Operating Instructions
Laser Particle Sizer
"analysette 22"

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881210VB

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Operating Instructions
Laser Particle Sizer

"analysette 22"

The Laser Particle Sizer "analysette 22" is a universally applicable unit for determining particle size distributions of all kinds of solids. These can be measured either in suspension in a measuring cell or dry by feeding them through a solid particle doser.

The measuring range can be selected between 0.16 µm and 1160 µm in as many individual steps as required by simply shifting the measuring cell along the sturdy support. The required position of the measuring cell along a desired measuring range is displayed on the monitor. The smallest range covers the particle sizes between 0.16 µm and 25 µm which are of considerable interest in many cases and does so in high-resolution. The time required for a measurement is approximately 2 minutes.

1. Operating Principle

During irradiation of the sample, a laser beam generates a diffraction pattern in which the laser light is deflected at various scatter angles depending on the grain size of the individual particles. Particles having the same size scatter at the same angle and the intensity of the scattered light provides information on the relative number or quantity of these particles. The angle and related intensity distribution is recorded using a special multielement detector.

A connected computer calculates particle distribution in 31 channels according to grain size and percentage volume from the many diffraction patterns generated during a measurement.

The many diffraction patterns generated during a measurement are used in conjunction with an interfaced computer to calculate the particle distribution into 31 classes based on grain sizes and mass components. The results are displayed on a monitor either as a frequency distribution, a cumulative curve or in tabular form, and can be subsequently printed out on a plotter, stored on floppy disks or transferred via an interface to a central computer.

Since no material-specific data are used when measuring solid samples (dry or in suspension), mixtures of differing composition and density, e.g. soil samples or river sediments, can also be examined to determine their particle size distribution.

2. General Description of the Instrument

The "analysette 22" Laser Particle Sizer consists of three units and an additional printer:

The measuring unit contains a helium-neon laser, the related optical system, the measuring cell for suspensions (or the nozzle arrangement for blowing out the solid particles and the related suction unit), and a multielement detector which allows particle size distribution into 31 classes. These components are rigidly connected by a special mechanical construction, with the entire, extremely stable structure being mounted on a flexible support in a sturdy housing so as to prevent external mechanical influences from affecting the optical system.

The dispersion unit for measuring samples in suspension contains an ultrasonic bath, an agitator, and a centrifugal pump for dispersing and transporting the solid sample and is connected to the measuring unit by hoses.

The interfaced screen computer controls the measuring sequence and calculates the measurement results. These are then displayed, printed out, stored or transferred to a central computer as required.

For "dry" measurement of an air-borne particle beam, a dispersion and suction unit is placed in the measuring unit. The solid sample is prepared in the dry dispersion unit used as well as or instead of the supply unit for measurements in suspensions.

3. Setting Up the Instrument

The "analysette 22" should be set up on a flat, stable base. It need not be secured to the base. Mechanical vibrations or oscillations can affect the validity of the measurements. Similarly, high temperatures (sunshine, heating units, etc.), dusty environments where dust may penetrate the measuring unit, and extreme humidity (>85%) must be avoided.

While the instrument is in operation the ambient temperature must not exceed $35^{\circ}C$ or drop below $10^{\circ}C$. It can be stored in temperatures of $1^{\circ}C$ to $40^{\circ}C$. If the storage temperature drops below $1^{\circ}C$ it must be warmed up to at least $10^{\circ}C$ before being switched on.

The location selected for the measuring unit must ensure good accessibility so that the measuring cell and adjusting elements can be reached easily when opening up the cover. The dispersion units are located near the measuring unit so that the connecting hoses between the units can be kept as short as possible.

3.1 Hose Connections

The procedure for converting the "analysette 22" from measurement with solids dispersion unit to measurement with liquids dispersion unit, or the other way round, is described in Point 14.2.

3.1.1 Liquid Dispersion Unit

The liquid dispersion unit and measuring unit are connected by two hoses. The polyethylene or silicon hoses coming out of the rear panel of the measuring unit are connected to the nipples of the dispersion unit so that "to cell" is connected to "to cell" of the measuring unit and "from cell" to "from cell" of the measuring unit. In the measuring cell, the test liquid flows from the bottom upwards if the hoses are correctly connected to the measuring unit.

The "OUT" hose connection of the supply unit is used for dis-charging used test and flushing liquids.

The "IN" connection of the dispersion unit is used for filling the measuring apparatus and is either connected to a reservoir containing test liquid or to a central feedline supplying e.g. demineralized water containing no particles. Particular attention must be paid to ensure that no pressure can build up in this hose line (max. 0.1 bar).

3.1.2 Solids Dispersion Unit

The solids dispersion unit and measuring unit are connected by two hoses. For this purpose, the hoses projecting from the rear of the measuring unit are connected to the rapid-action hose coupling on the rear side (compressed air supply for subsequent dispersion) and the hose for transporting the solid sample is secured to the pipe section (by means of a hose clamp). The compressed air supply of the whole unit is connected on the side via the rapid-action hose coupling.

It must have at least 4-6 bar which is reduced to 1.5 - 2 bar by means of a pressure reducing valve. The needed air flow must be between 1.5 and 7 m^3.

3.2 Electrical Connections

3.2.1 Agreement of Voltage and Current

Before connecting the unit, the voltage and current values specified on the nameplate should be checked for agreement with the values of the power supply to be used:

220 V AC current with protective conductor; fuse max. 16 A

It must be ensured that the complete unit is connected to the same power supply (same cycle, same fuse circuit).

3.2.2 Stability of the Supply Voltage

Stability of the supply voltage ($< \pm$ 5% deviation) is a particularly vital requirement for units featuring computer components. Where supply networks are not free from disturbance (spikes from switched inductive loads or clocked power supply units), it is advisable to connect an upstream voltage stabilizer (Order no. 20.600.00)

3.2.3 Electrical Connection Lines

Once the hose connections have been completed, the signal and supply line connections are then made:

The plug-in connections of the screen computer are located behind the sliding doors on both sides.

The measuring unit and screen computer are connected by means of the accompanying, shielded ribbon (large connector fits into the measuring unit). The cable lug connected to the ground wire is inserted underneath one of the screws on the metal computer chassis near the terminal strips, and here screwed down securely.

The printer is linked to the computer by means of the accompanying connection cable. (Centronics connector).

The smaller cable with 9-pole connector on both sides is used for connecting the dispersion units to the measuring unit. (Sub-D miniature connector).

The measuring and dispersion units, the screen computer (left side) and the printer are each connected to the power supply network via separate power lines. (The enclosed supply cables with the plugs printed in red are intended for the dispersion units and measuring unit. They have been specially produced and are fitted with electronic filters to ensure non-disturbance operation. They should not be exchanged.)

3.2.4 Electrical Fuses

The equipment fuses are located in the plug receptacles of the measuring and control units and the screen computer and can be pulled out after opening the cover.

Spare: fine-wire fuse 2 A semi-delay 5 x 20

4. Initial Installation

After the measuring system has been set up and all hoses and electrical supply and signal lines connected, **the first step is to switch on the screen computer.**

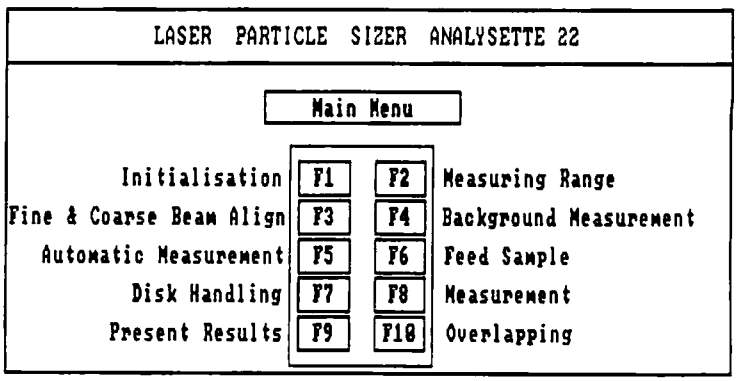
Drive A, the floppy disk drive is open and contains no floppy disk. The supply and measuring units and the printer are not switched on until the computer has been activated.

* If the computer has been switched off during operation, it is
* necessary to switch off the supply unit, switch on the
* computer and only then switch the supply unit back on before
* recommencing operation.

After the screen computer has been switched on, the program starts automatically and, after a few seconds, a FRITSCH emblem and copyright information is faded onto the monitor. The opening menu is then displayed.

Drive A (disk drive) initially remains empty. Only when the opening menu is displayed can the floppy disk be inserted into drive A (writing facing flap) and the flap closed.

The main menu appears on the monitor:



4.1 Preparation for Initial Alignment of the Laser Beam

Although the instrument has been adjusted at the factory prior to delivery, the laser beam alignment should be checked before being used for the first time.

The laser beam stabilizes after approx. 10 minutes "warm-up time", at which time the alignment can be performed.

4.1.1 Initial Alignment for Measurement in Suspension (Liquid)

Fill the measuring cell with clear, bubble-free test liquid.

The test liquid comes into contact with stainless steel, glass, Teflon and Viton within the instrument's system (supply and measuring unit).

Besides water, a number of monovalent, divalent or trivalent alcohols (ethanol, isopropanol, glycol or glycerol), gasolines (petroleum ether), mineral oils (petroleum) and organic oils (soya oil, nut oil) can be used as test liquids. It is also possible to use e.g. cyclic aromatic substances (ring hydro-carbons such as toluene, benzenes or aniline). The system is also resistant to alkanes (hexane, heptane) and aldehydes (formaldehyde).

No other liquids may be used without prior consultation with the manufacturer.

The following must not be used:

Ketones (acetone), ether, fluorochlorohydrocarbons, cholorinated hydrocarbons, acetic acid and its derivates, undiluted acids and bases.

Approximately 6 cm height of very clear test liquid is poured into the ultrasonic bath of the dispersion unit and the circulating pump switched on. After the pump has been running for a short time, it is switched off briefly and, after some 10 sec., is switched on again. This procedure is used to bleed the pump system and should be repeated as many times as necessary until no more air bubbles enter the bath through the inlet. Alignment can then begin.

4.1.2 Initial Alignment for Measurement with Dry Dispersion Unit

If measurements are to be performed with the dry dispersion unit, no preparations are required for the alignment.

4.2 Coarse Beam Alignment

For this purpose, function key

> "F 3" is depressed to call up the program section
> "**Coarse & fine beam alignment**" in the main menu

as well as function key

> "F 1" to call up the program section
> "**Coarse beam alignment**" in the following menu.

This program makes it possible to perform a coarse check of the laser beam alignment. A symbolic representation on the monitor shows the sensor ring system and the position of the focussed beam.

The cursor flashes on the ring on which the laser beam is focussed, or which is currently receiving the strongest light signal.

In a very light room, it is quite possible that light falling on the outermost ring of the sensor from outside may produce the strongest signal. In this case, the cursor flashes on an outer ring - even if this is already well aligned. The actual position of the beam is shown once the cover has been closed. (If the system has been correctly aligned, it flashes in the centre of the concentric rings).

> In the event that the laser or supply unit are not switched on, the message "LASER OFF" appears on the screen accompanied by an acoustic signal. As soon as both units have been switched on, the message changes to "LASER ON".

"LASER OFF" may also appear if the laser beam is seriously disoriented. In this case, the acoustic warning can be cancelled by opening the measuring unit, since this allows sufficient light to fall on the sensor. (If necessary, the light of a torch may also be used.)

The laser beam is aligned as follows:

With the cover open, the fixing screws lying opposite the two set screws on the lens holder are loosened and the two set screws adjusted so that the laser beam passes through the hole in the centre of the sensor, in other words so that the light spot on the sensor disappears in the hole or flashes in the centre of the image on the screen.

The position of the beam can be read off on the computer screen with the cover closed:

Flashing on a right-hand segment of a circle means that a correction has to be made to the left (in other words, the beam must be moved backwards in the unit), while flashing on a left-hand segment means it must be moved to the right (i.e. forwards in the unit).

The set screw near the lens system moves the beam (cursor) in horizontal direction; the beam is moved forwards by turning in the screw.

The screw located above the lenses moves the beam in vertical direction; turning in the screw moves the beam upwards.

The fixing screws opposite the set screws are only secured in position once the beam has been aligned correctly. The alignment is checked again with the unit closed.

4.3 Fine Beam Alignment

(This procedure is also used in the standard measurement program for checking the beam alignment.)

Approximately 6 cm of very clear test liquid is poured into the ultrasonic bath of the dispersion unit and the circulating pump switched on, so that the measuring cell is filled with clear liquid. (See p. 5, 4.1.1)

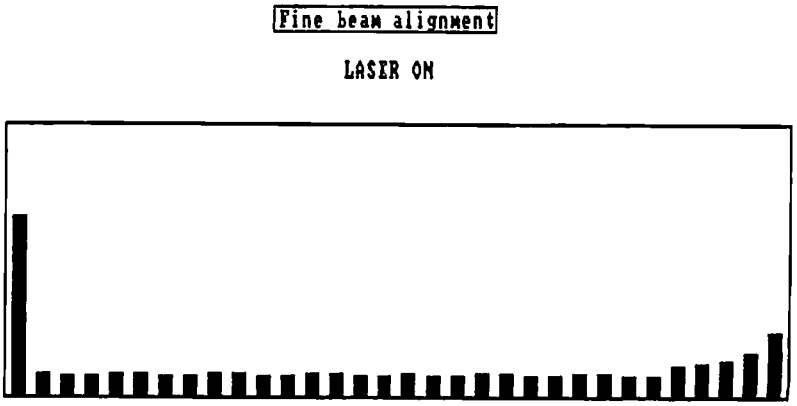
For alignment, function key

"F 3" is depressed to call up the program section
"Coarse & fine beam alignment" in the main menu

as well as function key

"F 2" to call up "Fine beam alignment" in the following menu.

This subprogram enables fine adjustment of the laser beam and, at the same time, indicates the beam intensities striking the individual rings of the sensor.



In the event that the laser or supply unit are not switched on, the message "LASER OFF" appears on the screen accompanied by an acoustic signal. As soon as both units have been switched on, the message changes to "LASER ON".

This message may also appear if the laser beam is seriously disoriented. In this case, the acoustic warning can be cancelled by opening the measuring unit, since this allows sufficient light to fall on the sensor. (If necessary, the light of a torch may also be used.)

The intensities of the rings are displayed symbolically as vertical lines on the left-hand side of the monitor. The intensity of the central beam is shown on the left followed, from left to right, by the intensities of the neighbouring rings moving outwards from the central beam. If the instrument is closed, the first line of the central beam indicates a relative intensity of approx. 3/4 of the possible overall level if the measuring cell is filled with clear, bubble-free test liquid and if the laser beam has been accurately adjusted. In this case, the intensity of the neighbouring rings is very low and the corresponding lines are only around 1 - 2 mm high.

With the cover open, only the first lines on the left are low and can be used for aligning the beam. The following lines can only be evaluated when the cover has been closed. If lengths of more than approx. 10 mm are displayed, especially in the medium range, this means that the cell or test liquid has been contaminated by fine particles.

The laser beam is aligned as follows (in principle the same as for coarse alignment):

With the cover open, the fixing screws lying opposite the two set screws on the lens holder are loosened and the two set screws adjusted so that the intensity of the central beam (length of the first line) is increased and the neighbouring lines are reduced.

The set screw located near the lens system moves the beam (cursor) in horizontal direction; the beam is moved forwards by turning in the screw.

The screw located above the lenses moves the beam in vertical direction; turning in the screw moves the beam upwards.

The fixing screws opposite the set screws are only secured in position once the beam has been aligned correctly. The alignment is checked again with the unit closed.

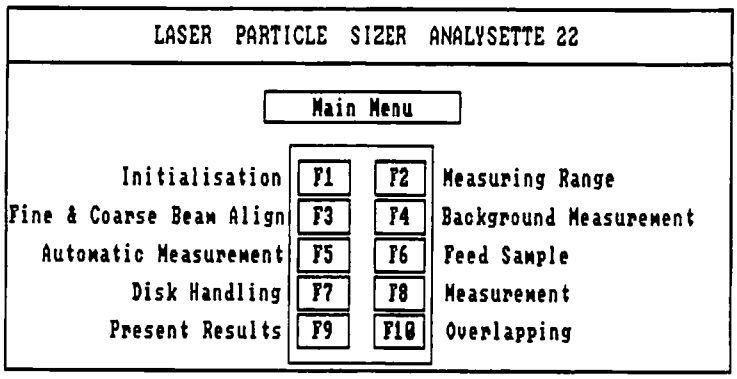
5. Performing Measurements

After the measuring system has been set up, all hoses fitted and all electrical power and signal lines connected,

the first step is to switch on the screen computer.

Drive A, the floppy disk drive is open and contains no floppy. The supply and measuring units and the printer are not switched on until the computer has been activated.

After the screen computer has been switched on, the program starts automatically and, after a few seconds, a FRITSCH emblem and copyright information is faded onto the monitor. The main menu is then displayed.



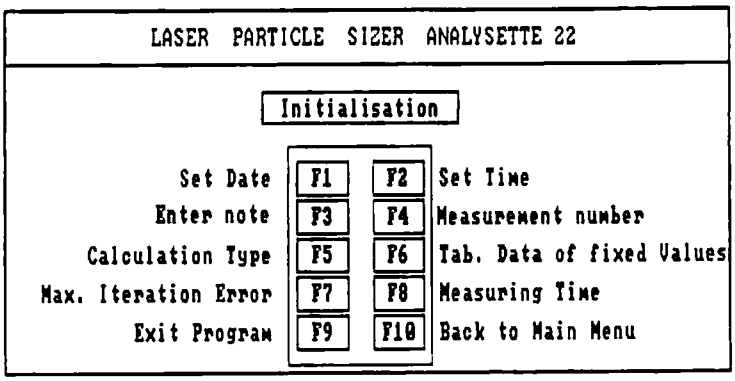
5.1 Input of Parameters and Remarks

In the main menu, depress function key

"F 1" to call up **"Initialisation".**

Before measurements are begun, the date, time, parameters for the documentation, consecutive number of the measurements to be performed and variations regarding the type of calculation can be input with this submenu.

(These data are output with each result, stored with it, and reloaded from floppy disk with each result.)



5.1.1 Set Date

By pressing the function key

> **"F 1" "Set Date"**, the current date can be entered.
> (Not necessary where the computer has an integrated calendar and clock)

The line "Last Date was:..." shows the last date entered. When a number is input for "Enter Day": (initiation with RETURN), a new date is written over the old one. The procedure is the same for the month (Enter Month:) and the year (Enter Year:). The date already shown in "Last Date was:..." is adopted by the computer if initiated with "RETURN".

The program disregards any date specifications (e.g. 32.13.1884) which are obviously "incorrect" and issues the note "wrong date". The date then has to be input again.

5.1.2 Set Time

By pressing the function key

> **"F 2" "Set Time"**, the current time can be entered.
> (Not necessary where the computer has an integrated calendar and clock)

The current time is shown in the bottom line (Actual Time is:...). The minutes and hours shown on the computer clock can be changed by entering new values. It is also possible, without entering new times, to adopt the time currently shown by initiating with RETURN. The program then returns to the subroutine.

5.1.3 Enter Notes

By pressing the function key

> **"F 3" "Enter notes"**, notes on the measurement can be entered.

The last note is displayed in the bottom line and can be adopted by depressing the RETURN key. By inputting a new note (not longer than 40 characters; only digits and upper-case and lower-case letters), this is overwritten and stored by the computer after initiation with RETURN. The menu of the subroutine is then faded back onto the monitor.

5.1.4 Measurement Number

By pressing the function key

> **"F 4" "Measurement number"**, the start number of the next measurement can be entered.

The number entered (e.g. 1) is stored by the computer after initiation with RETURN, is automatically incremented for each subsequent measurement and is printed out in the measurement logs. In this way, measurements can be differentiated in the log even if they have been given the same notes. After RETURN the program jumps back to the submenu.

5.1.5 Calculation Type

By pressing the function key

> **"F 5" "Calculation type"**, the algorithm which is to be used for calculating the particle distribution can be entered.

Two algorithm types can be selected. Firstly, calculation of the particle distribution without specification of a specific model (Model Independent). This is recommended as standard. For special cases where a distribution is to be calculated using ROSIN RAMLER (double logarithmic RRSB distribution), a "2" is input and initiation performed with RETURN. If the "Model Independent" distribution is to be calculated, a "1" is input causing this submenu to be faded back onto the monitor. (It is only possible to "exit" from this subroutine by entering one of these two numbers. This program section cannot be exited by entering RETURN.) (See also 18.4)

5.1.6 Selection of Fixed Values (%-/µm) for Tabular Printer

By pressing the function key

> **"F 6" "Fixed values (%-/µm) for tabular printer"**, fixed points for results output can be selected.

This subroutine can be used to select up to five fixed values in advance. It is possible to freely select either the percentages for particular particle sizes or the particle sizes for particular percentages. This is particularly useful where specific percentages or particle sizes are required for the evaluation of the results.

Since a spline function is used to calculate the interim values, any percentage or particle size can be entered - e.g. inputs such as 10%, 20%, 50%, 63.2% and 90%. The corresponding particle sizes are then calculated and printed out in a small table when the tabular values are output. (See example on p. 25)

5.1.7 Maximum Iteration

By pressing the function key

> **"F 7" "Maximum Iteration"**, the criterion for interrupting the calculation of the particle distribution can be specified.

This program can be used to alter the criteria for interrupting the calculation of particle size distribution. Normally, calculation is interrupted either when 15 iteration steps have been calculated or when the deviations from optimally matched values are smaller than 0.002.

This limit value can be freely selected within the range of 0.0004 to 0.01. The closer the particle size distribution of the sample corresponds to a simple mathematical function (e.g. a Gaussian distribution), the lower (e.g. 0.001) the limit value can be set.

5.1.8 Measuring Time

By pressing the function key

> **"F 8" "Measuring time"**, the time for the measurement of particle size distribution can be set.

This program can be used to alter the actual measuring time (number of individual system measurements while the particle size distribution of one sample is being determined).

By changing the multiplication factor (standard = 1), the measuring time can be extended by a factor of up to 100. If the maximum factor of 100 is entered, the time taken to measure a sample will be 20 minutes (12-MHz clock frequency of the computer).

5.1.9 Exit Program

The function key

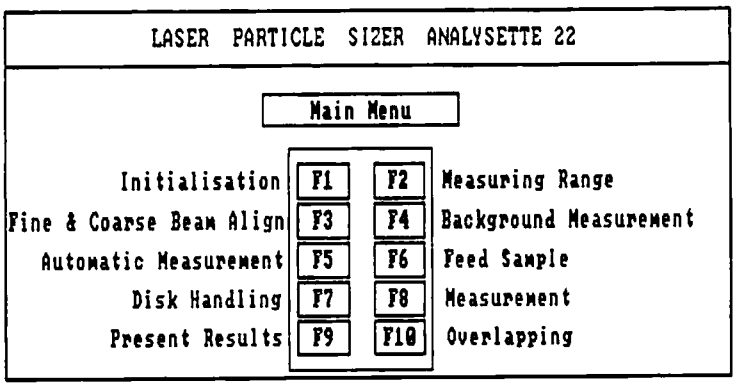
> **"F 9" "Exit program"**, is pressed to leave the program and return to the DOS system. (After answering the question on the screen with "y".)

All the data and notes input in these subroutines
("Initialisation") are stored until new data are entered.

By pressing the function key

> **"F 10" "Back to main menu"**, the program returns to the main menu.

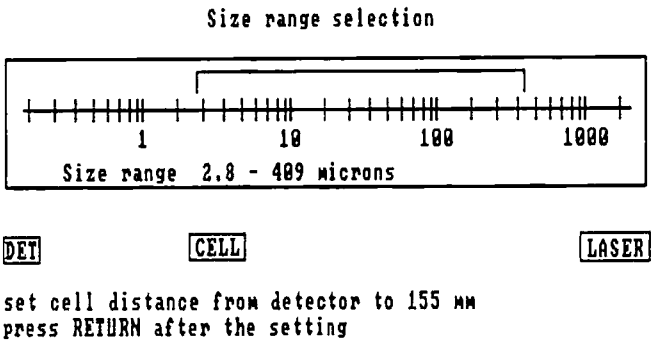
5.2 Selection and Adjustment of the Measurement Range



By pressing the function key

"F 2" in the main menu, the
"Measuring range" subroutine for entring the desired measuring range is called up.

A symbolic representation of the full range is then displayed on the screen (more than 3 decades). A bracket in the upper section of the image shows the current measuring range. This measuring range is also displayed as a numerical value in microns (lowest limit value of the smallest measuring channel or upper limit of the largest measuring channel) in the line below the scale.



In each case, the measurement range encompasses more than 2 decades and can be continuously selected and adjusted in as many individual steps as required by simply shifting the measuring cell. The smallest range covers the particle sizes 0.16 µm to 24 µm, the largest range 8 µm to 1160 µm (lower and upper class limits).

By actuating the control keys for the cursor, the measuring range is adjusted in accordance with the symbolic representation. Every time the cursor control keys are actuated (left or right), the bracket (and therefore the measuring range) in the display moves left or right. (If it is to be moved a larger distance, the jump interval for the bracket can be increased by depressing the right-hand "SHIFT" and cursor control keys simultaneously, thereby allowing the set measuring range to be changed more quickly.)

The required position of the measuring cell for the selected measuring range is displayed at the bottom of the monitor:

"Set cell distance from detector to ... mm"

It is essential that the position specified at this point agrees with the actual position of the measuring cell. Otherwise the subsequent measurement and calculation of the particle size distribution is worthless.

In order to move the measuring cell to the position prescribed by the computer, the unit is opened and the cell moved by hand so that the indicator attached to the cell points to the number on the measuring strip which agrees with the number read off the monitor.
(The accuracy required in setting the position is ± 1 mm.)

For safety's sake, a question is faded onto the monitor after this program section has been left which can only be answered with "Y". It is possible to jump back to the program again by entering "ESC".

(Two measurements with two different measuring ranges can be carried out directly one after the other to expand the measuring range. See Section 12, Overlapping Measurements, for a detailed description of measurements taken in direct succession.)

5.3 Background Measurement

A background measurement must be performed before every measurement in order to eliminate the influence of the test liquid when performing measurements in suspension. This applies particularly when the measuring range is changed. During this process, any slight contaminations detected during preceding measurements are recorded and their influence on the current result eliminated.

When performing measurements with the dry dispersion unit, there is no need to perform another background measurement when the measuring range is changed, since no disturbances can occur at any measuring position when performing the background measurement in the free jet. There is also no need to perform any intermediate background measurement where several measurements are performed in suspension directly one after another without any change in the measuring range.

When expanding the measuring range by performing measurements with combinable measuring ranges in direct succession, the background measurements are also carried out in direct succession. In measurements of this type with a measuring range over 3 decades wide, the movement of the measuring cell is controlled by the program via commands on the monitor.

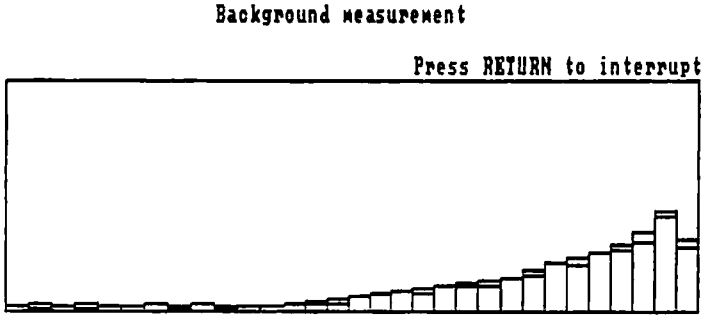
(See here Section 12, Overlapping Measurements, where a subsequent background measurement is automatically carried out and is described in detail.)

Approximately 6 cm of very clear test liquid is poured into the ultrasonic bath of the dispersion unit and the circulating pump switched on. After the pump has been running for a short time, it is switched off briefly and, after some 10 secs., is switched on again. This procedure is used for bleeding the pump system and should be repeated as many times as necessary until no more air bubbles enter the bath from the inlet.

(The beam alignment can be checked (see 4.3) after filling the ultrasonic bath with clear liquid. However, adjustment is only necessary in a very small number of cases.)

In the main menu, the function key

"F 4" is used to call up the subroutine **"Background measurement"**



Directly following this, the intensities of the 31 channels are displayed symbolically on the monitor.

The image is cleared automatically after a few seconds, and the data obtained during this measurement and thus the characteristics of the test liquid or the background, are stored in the computer for later evaluation.

(Background measurement values are retained even when the unit is switched off, and are taken as the basis for all subsequent measurement calculations. The values of the "old" measurement are only overwritten - and thereby lost - when a new background measurement is performed.)

The background measurement can be interrupted prematurely by depressing the RETURN key. The program then jumps back to the main menu and the values from an earlier background measurement which are stored in the computer are retained unchanged.

This interruption may be necessary, if, for example, the background measurement is selected unintentionally - i.e. if the values measured earlier must not be overwritten.

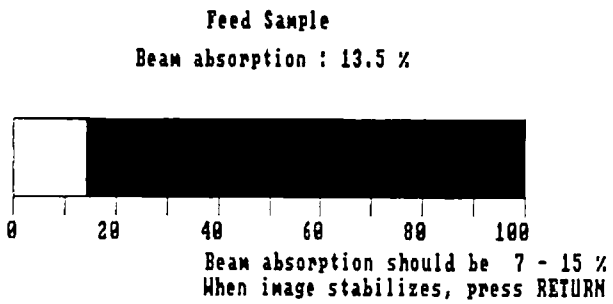
5.4 Feeding of Sample with Liquid Dispersion Unit

In the liquid dispersion unit, the sample is added to the test liquid either dry or in the form of a suspension after being dispersed first in an external process (prior to this, the measuring range is set, see Point 5.2, and a "background" measurement performed, see Point 5.3; the circulation pump and the agitator have been switched on).

The quantity of sample fed into the ultrasonic bath can be checked by calling up the **"Feed sample"** subroutine by depressing the function key

"F 6" in the main menu.

A bar chart then appears on the monitor which symbolically indicates the extinction of the laser beam.



A small quantity of the sample to be examined (approx. 0.5 - 1 g) is now fed into the ultrasonic bath and the latter then switched on (if advantageous for dispersion).

Depending on the dispersibility of the sample, it is either fed directly into the ultrasonic bath in dry form using a spatula or is first prepared in the test liquid in a separate dispersion process and is then added to the ultrasonic bath in the form of a suspension.

The quantity added is displayed in relative values on the computer screen. (No masses or quantities need therefore be measured out in advance.) The bright field of the screen (shown black in the figure above) becomes smaller as the quantity increases.

The measurement can begin as soon as a stable dispersion has been achieved after a short time by means of the ultrasonic effect and the agitator. (Only small deviations are displayed in the most favourable range for the measurement lying between approx. 7 and 15 % beam absorption.)

If the sample contains a relatively large component of fine-grained material in the range 1-10 m, the beam absorption percentage should lie in the lower range, i.e. at around 10 %. If there is a high component of coarse grain material without fine grain component, the measuring result is still acceptable, even for concentrations up to approx. 25 %.

RETURN brings the main menu back onto the monitor.

5.5 Feeding of Sample with the Solids Dispersion Unit

Particle size distributions from approx. 1 to approx. 1160 micron can be measured with the solids dispersion unit. It is first necessary to connect the dispersion nozzle and dust extractor to the measuring unit as described in Point 14.2 and to connect the solids dispersion unit to the measuring unit as described in Point 3.1.2.

During measurement, a mechanically-driven piston supplies the sample from the cylinder into which it has been filled to a rotating brush. The brush picks up and disperses the sample (whose quantity can be preset by adjusting the piston speed) and transports it into an air current flowing across the brush (brush air). The individual sample particles are carried via a connection hose to the measuring unit, where they are redispersed with the aid of a secondary, adjustable air current (nozzle air) and blown at high speed into the path of the laser beam.

The nozzle on the other side is attached to an extraction device which sucks the measured sample out of the measuring unit. The dust extractor is automatically switched on whenever the "air" key on the unit is depressed. This ensures that the samples transported into the unit are always removed. (Maximum dust extractor power is 100 Watts).

> **Before switching on the compressed air ("air" key), it is imperative to insert the extraction hose of the dust extractor into the rear panel of the measuring unit and to switch on the dust extractor.**

In preparation for measurement, the electrical connection cable of the dust extractor must be plugged into the dispersion unit and the dust extractor switched on. The unit can then be switched on via the ON/OFF switch located on the inlet connector for non-heating apparatus, and the "air" key on the smallr, right-hand control panel can be pressed. The air flow can then be set to a value of between 1.5 and max. 2 bar (readable on the pressure gauge) using the "main pressure regulation" reducing valve. A brush pressure of 0.7 bar is then set via the "pressure brush regultion" pressure gauge.

> **The pressure of the air flowing over the rotating brushes may in no case exceed 0.8 bar. Excessive air pressure at this point will result in damage to the rotating brush bearings!!**

The pressure of the nozzle air is then set to a preliminary value of 0.5 bar using the "pressure nozzle" pressure gauge located on the left-hand side. This pressure may be raised to up to 1.5 bar, depending on sample dispersibility.

> **If there is no great variation in the pressure of the air supply line, it is sufficient to check the air pressure values before measurement.**

When performing a measurement, the sample is first filled into the cylinder. For this purpose, the door in the right-hand side is opened and, after pressing the "air" key, the support plate together with the piston operating within the cylinder is lowered by pressing the down key. (Simultaneaously pressing the "air" and "down" keys switched on the preset brush and nozzle air and thus also cleans the dispersion unit.)

Once the lower support plate has been lowered, the "stop" key is pressed; this switches off both compressed air and feed. The cylinder securing plate is then removed and the solids cylinder extracted from below.

In order to generate a flow of particles which is as homogeneous as possible, the solids cylinder must be filled uniformly. Depending on its characteristics, the sample is filled into the solids container centimeter by centimeter and lightly compressed with the aid of a stopper.

The filled solids container is inserted (groove facing the left) and secured by the cylinder securing plate.

After depressing the "air" and "up" keys, the sample can now be propelled into the brush region at maximum piston speed (position 10 on the "speed" potentiometer). However, the "stop" key is pressed to halt the air and piston as soon as the laser beam in opened measuring unit lights up, thereby indicating that the brush has picked up the sample.

For actual measurement, after carrying out a background measurement (Point 5.3), and in accordance with Point 5.4, the speed of the piston is set with the aid of the potentiometer to optimise the quantity of sample supplied. Beam absorption should in no case exceed approx. 15 %.

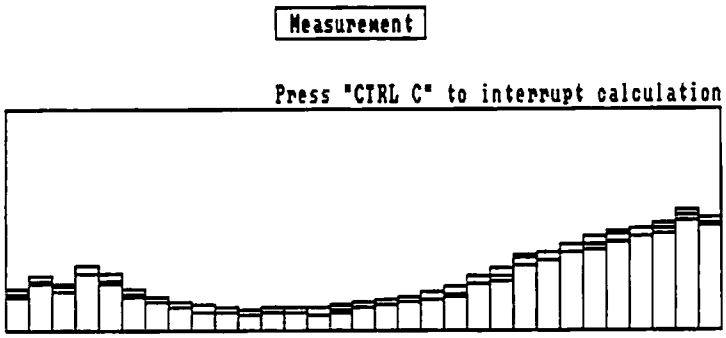
5.6 Measuring Particle Size Distribution

Before each measurement with the liquid dispersion unit, the measuring system must be bled again by switching off the pump and then reactivating it.

In the main menu, the function key

"F 8" is depressed to call up the **"Measurement"** program.

Immediately after this, the relative intensities of the 31 measuring channels are displayed on the monitor in symbolic form, in a similar way to the background measurement.



After a few seconds, the text "wait, program running" appears above this bar chart to indicate that the measurement has been completed and that mathematical evaluation of the measurement has begun. When measuring with the solids dispersion unit, the dosing piston feed can be deactivated at this point (depress key "Stop/Down"). The measurement results remain stored when the computer is switched off - even if they have not been stored on the floppy disk. (Results can only be deleted by overwriting with a new measurement).

The main menu reappears on the monitor.

If a background measurement was not performed before the particle size distribution measurement, a note appears on the monitor: "Measure background first". In this case, this background measurement must be selected in the main menu (see Point 5.3); measurements with the liquid dispersion unit hereby first require the ultrasonic bath to be reflushed and thus the measuring cell refilled with clear test liquid.

5.7 Flushing the Liquid Dispersion Unit

As soon as the measurement itself has been completed, the measuring cell must be flushed. The test sample should not be left unnecessarily in the supply unit - and thereby in the test circuit as a whole - over any long period of time.

Under no circumstances may the conveyor pump of the liquid dispersion unit be switched off when there is a test sample in the test circuit.

The medium in the liquid circuit comes to rest when the conveyor pump is switched off. The particles in the liquid then settle, possibly resulting in blockages or particles being deposited in the hose system.

If the "IN" hose connection is linked up to a connection on the supply system, both ball valves are turned so that the tips of their rotary toggles point outwards. Turning the rear ball valve drains the test circuit through the hose which is fitted to the rearmost hose nipple. The front ball valve allows clean, fresh flushing liquid to enter through the hose fitted to the foremost nipple.

If the flushing liquid cannot be supplied via a hose for any reason, the front ball valve remains in the same position with the tip of the toggle pointing to the rear (inwards) and the flushing liquid enters the ultrasonic bath directly from above.

In each case, it must be ensured that the level of the flushing liquid in the ultrasonic bath is no higher than approx. 2 cm below the upper rim.

> The effect of the flushing operation can be easily monitored by means of the program "F 6" "Feed sample", since there is practically no beam absorption with clear liquid.
>
> (When the value of "0%" absorption is obtained in flushing, this corresponds to the value measured with clear liquid in the last background zero measurement. When performing a background measurement, absorption is set at "0". When the light bar fills almost the entire field, the measuring cell is as clean as it was for the last background measurement, and the next measuring cycle can be performed.)

The windows of the measuring cell must be checked if no satisfactory result is obtained even after a long period of flushing. Any dust sticking to the outer side of the windows may only be brushed away very carefully using a very fine hair pencil (optician quality). Any particles sticking to the inside of the windows can only be removed after opening the measuring cell (refer to Point 14.1 "Cleaning the measuring cell").

A further way of checking is possible after calling up the program section "Fine Beam Alignment". The height of the lines in the graphic display indicate the contamination still present. (Coarse component on left-hand side, fine component on right-hand side. Refer also to Point 4.1.2)

5.8 Cleaning the Solids Dispersion Unit

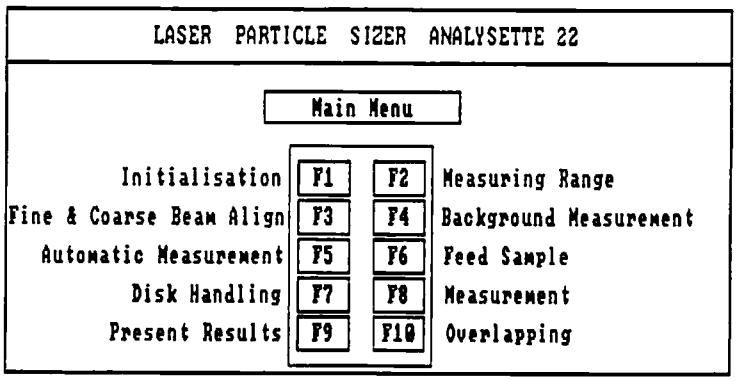
After completing the actual measurement itself (i.e. when the message "wait program running..." appears on the monitor), it is possible to stop the supply of new solids by depressing the "Stop/Down" key on the solids dispersion unit.

For as long as the compressed air remains activated, the rotating brush is blown out and is thereby cleaned automatically. The hose connection and the exhaust nozzle in the test unit also clean themselves automatically. The extractor, which is still active up until this point, removes all remaining traces of the sample.

Blowing out with compressed air is sufficient to clean the sample cylinder before adding the next sample. After unscrewing the right-hand flange, the rotating brush can be removed with the help of the threaded pin (thread M4), and also blown out. The brush must not be damaged during cleaning (its outer edge is specially finished - any loose or detached bristles must be removed). After reinserting the brush, the flange must be pushed in as far as it will go and screwed in securely at the correct angle.

ahu
6. Presenting Measurement Results

In the main menu,

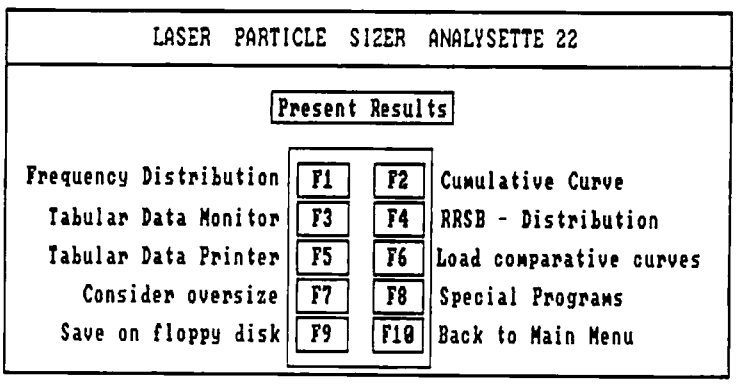

LASER PARTICLE SIZER ANALYSETTE 22
Main Menu
Initialisation F1 F2 Measuring Range
Fine & Coarse Beam Align F3 F4 Background Measurement
Automatic Measurement F5 F6 Feed Sample
Disk Handling F7 F8 Measurement
Present Results F9 F10 Overlapping

the function key

"F 9" is used to call up the submenu "**Present results**".

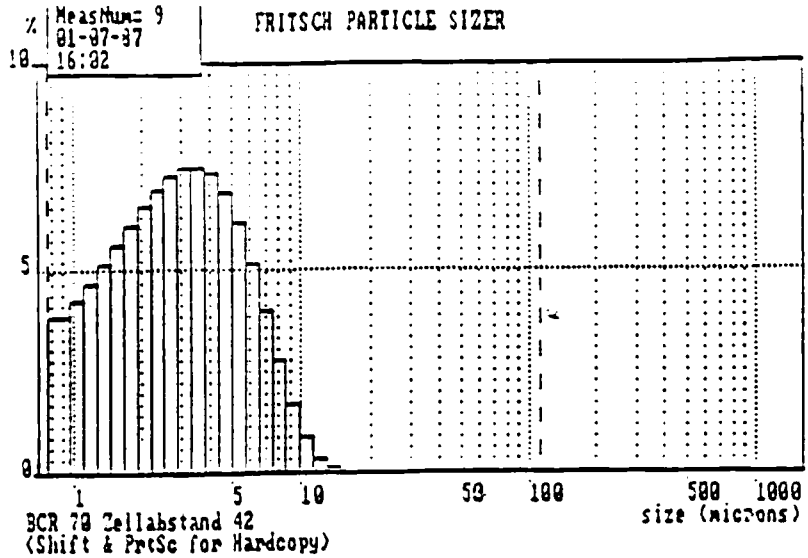
By activating certain function keys in this menu, it is possible to select the manner in which the results are presented. The results then appear immediately on the monitor or at the printer.

"F 9" is used to call up the submenu "**Present results**".

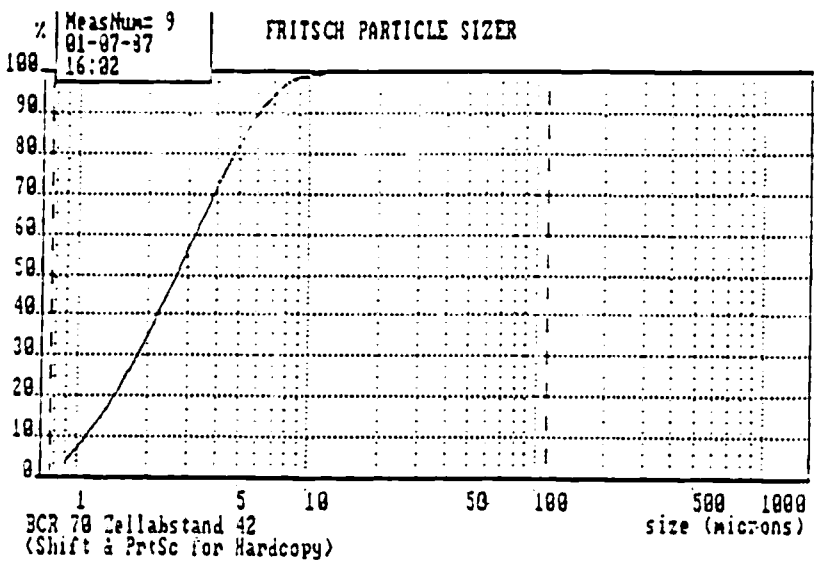

LASER PARTICLE SIZER ANALYSETTE 22
Present Results
Frequency Distribution F1 F2 Cumulative Curve
Tabular Data Monitor F3 F4 RRSB - Distribution
Tabular Data Printer F5 F6 Load comparative curves
Consider oversize F7 F8 Special Programs
Save on floppy disk F9 F10 Back to Main Menu

"F 1" : Frequency distribution
"F 2" : Cumulative curve
"F 3" : Tabular data on the monitor
"F 4" : Presentation of cumulative curve in log/log network (RRSB distribution)
"F 5" : Tabular data as printout
"F 6" : Loading of comparative curves for presentation with current result
"F 7" : Consideration of sieved values
"F 8" : Special programs
"F 9" : Saving the current measurement results
"F10" : RETURN to main menu

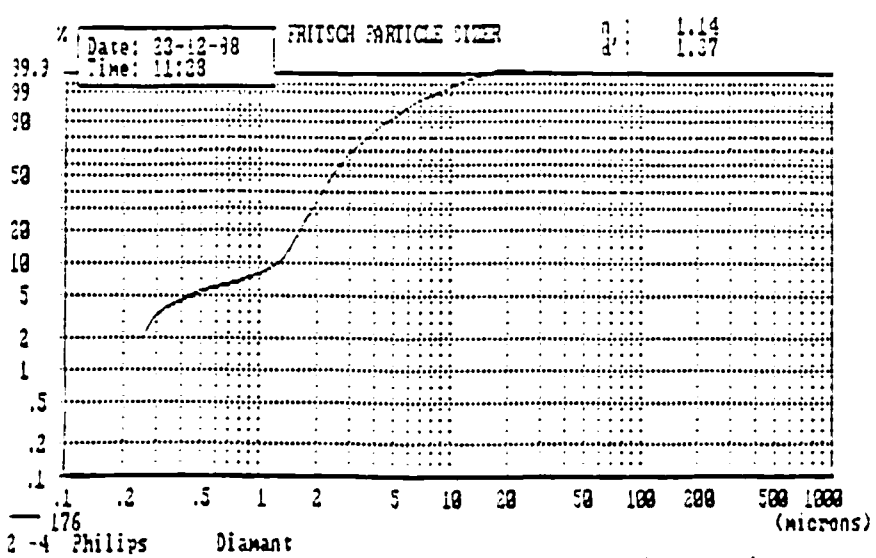
A copy of the screen contents is output on the printer by simultaneously depressing the SHIFT and PRINTSCREEN keys (identified by upwards-pointing arrow and PrtSc).



Function key "F 1": Frequency distribution



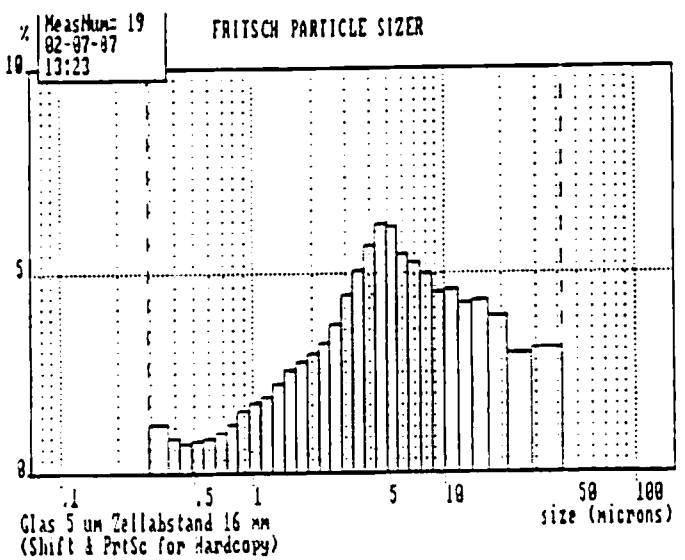
Function key "F 2": Cumulative curve



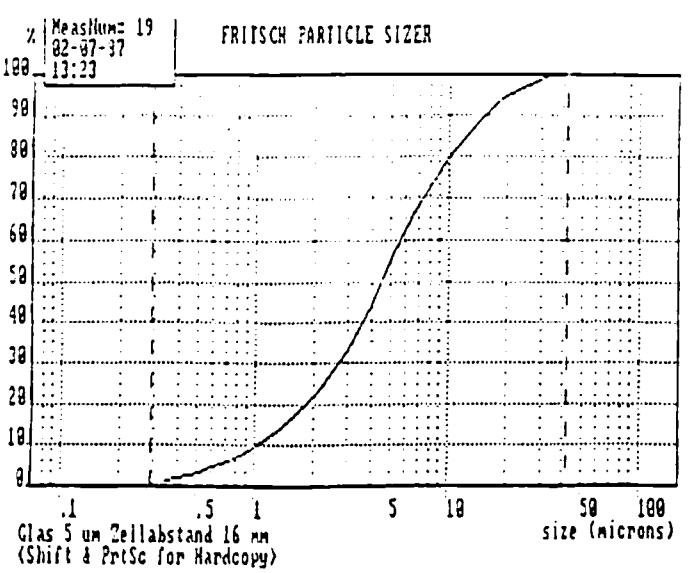
Function key "F 4": Presentation of cumulative curve in log/log network (RRSB distribution)

The program automatically decides the scale of the abscissae (scale of grain size in /um) for the graphic display. If the lower measuring limit of the lowest measuring channel lies below 0.8 /um, the abscissa shown on the monitor is graduated from 0.1 /um to 100 /um. For these measurements, the measuring cell is located at a position number less than 42 mm. All measurements for which the cell is located further to the left, i.e. at a value larger that 42 mm, are displayed with the abscissae graduated from 1 /um to 1000 /um.

The examples given are obtained from laboratory measurements. The latter page shows a measurement of the BCR 70 standard. The cell was positioned at 42 mm for the measurement. The current page shows a measurement for glass. The cell position in this case was 16 mm.



Function key "F 1": Frequency distribution



Function key "F 2": Cumulative curve

date 01-07-87 time 16:08 measure n. 9 page 1

BCR 70 Zellabstand 42

Beam Obscuration = 18.2 %

Average = 3.4 microns

Mean Square Deviation = 2.2 microns

Measure Reliability = 0.97

Number of Iterations = 67

All Data obtained using Rosin-Rammler Fit

Use arrows for paging up and down.

date 01-07-87 time 16:09 measure n. 9 page 2

BCR 70 Zellabstand 42

class size (microns)	frequency (%)	size (microns)	integral frequency (%)
0.8 - 1.0	3.8	0.9	3.8
1.0 - 1.1	4.2	1.0	8.0
1.1 - 1.3	4.6	1.2	12.7
1.3 - 1.5	5.1	1.4	17.8
1.5 - 1.7	5.6	1.6	23.3
1.7 - 1.9	6.0	1.8	29.4
1.9 - 2.2	6.5	2.0	35.9
2.2 - 2.5	6.9	2.3	42.7
2.5 - 2.9	7.2	2.7	50.0
2.9 - 3.3	7.4	3.1	57.4

Use arrows for paging up and down.

date 01-07-87 time 16:09 measure n. 9 page 3

BCR 70 Zellabstand 42

class size (microns)	frequency (%)	size (microns)	integral frequency (%)
3.3 - 3.8	7.5	3.5	64.9
3.8 - 4.3	7.3	4.0	72.2
4.3 - 5.0	6.8	4.6	79.0
5.0 - 5.7	6.1	5.3	85.1
5.7 - 6.5	5.1	6.1	90.3
6.5 - 7.5	4.0	7.0	94.2
7.5 - 8.6	2.8	8.0	97.0
8.6 - 9.8	1.7	9.2	98.6
9.8 - 11.3	0.9	10.5	99.5
11.3 - 12.9	0.4	12.0	99.9

Use arrows for paging up and down.

date 01-07-87 time 16:10 measure n. 9 page 4

BCR 70 Zellabstand 42

class size (microns)	frequency (%)	size (microns)	integral frequency (%)
12.9 - 14.8	0.1	13.8	100.0
14.8 - 17.0	0.0	15.8	100.0
17.0 - 19.5	0.0	18.1	100.0
19.5 - 22.5	0.0	20.9	100.0
22.5 - 26.1	0.0	24.2	100.0
26.1 - 30.9	0.0	28.3	100.0
30.9 - 36.8	0.0	33.4	100.0
36.8 - 44.6	0.0	40.1	100.0
44.6 - 56.0	0.0	49.1	100.0
56.0 - 74.3	0.0	62.9	100.0
74.3 - 110.3	0.0	86.3	100.0

Use arrows for paging up and down.

By depressing the function key "F 3" "Tabular Data Monitor", a string of images can be called up with the individual values of the results in tabular form and can be faded onto the monitor one after the other by "paging" using the cursor control keys.

By depressing the function key

"F 5" "Tabular data printer"

the results data are output in text mode at the printer. This form of results output offers particularly fast documentation of test results.

FRITSCH - LASER - PARTICLE - SIZER
ANALYSETTE 22

Parameters:

Measurement No.: 57 Date: 09.11.87 Time: 12.57

d10 = 27.89 **d50** = 84.23 **d90** = 198.78 micron

Polyester

SIZECLASS (micron) LOW	AVERAGE	HIGH	FREQ. (%)	CUMUL. (%)
4.2	4.9	5.2	0.29	0.29
5.2	5.6	6.0	0.21	0.50
6.0	6.4	6.9	0.23	0.73
6.9	7.4	7.9	0.24	0.97
7.9	8.4	9.1	0.26	1.22
9.1	9.7	10.4	0.32	1.54
10.4	11.1	11.9	0.41	1.95
11.9	12.7	13.6	0.52	2.47
13.6	14.6	15.6	0.66	3.13
15.6	16.7	17.9	0.85	3.98
17.9	19.2	20.5	1.09	5.07
20.5	21.9	23.6	1.42	6.50
23.6	25.2	27.0	1.81	8.31
27.0	28.8	31.0	2.26	10.57
31.0	33.1	35.0	2.57	13.31
35.5	37.9	40.7	3.22	16.53
40.7	43.4	46.6	3.80	20.33
46.6	49.8	53.4	4.52	24.85
53.4	57.0	61.1	5.27	30.11
61.1	65.3	70.0	6.01	36.13
70.0	74.7	80.2	7.12	43.25
80.2	85.6	92.0	7.77	51.02
92.0	98.4	105.9	8.33	59.35
105.9	113.4	122.4	8.97	68.14
122.4	131.5	142.6	7.78	75.92
142.6	153.8	167.6	6.53	82.45
167.6	181.3	199.5	5.27	87.73
199.5	217.8	242.2	4.73	92.46
242.2	266.6	303.9	3.90	96.37
303.9	341.2	406.3	2.34	98.70
406.3	471.4	601.5	1.30	100.00

Fixed Particle Size (Screenings):

0.32 % < 5.00 microns
1.63 % < 10.00 microns
5.51 % < 20.00 microns
25.02 % < 50.00 microns
60.27 % < 100.00 microns

7. Rapid Storage of the Results

In submenu "Present results", it is possible by depressing function key

"F 9" "Save on floppy disk"

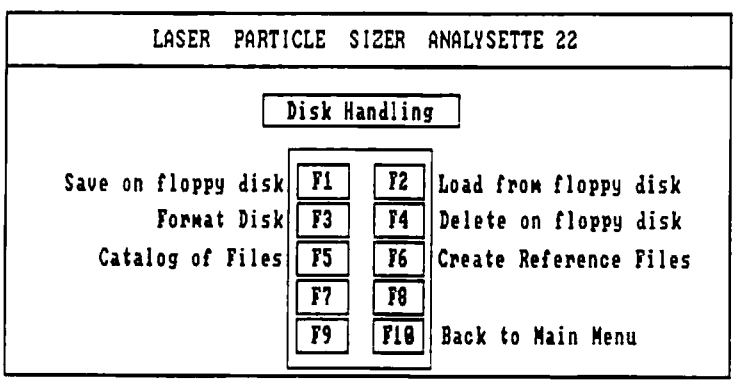
to jump directly from the program for displaying the results into the storage program. The program itself does not differ from the program described in Point 8.1 below. This method simply serves to cut the path via the main menu and the submenu "F 7" "Disk handling".

8. Disk Handling

The subroutine "Disk utilities" for working with floppy disks is called up in the main menu.

By pressing the function key

"F 7" "Disk handling"



the corresponding subroutine can be called up via the function keys.

8.1 Saving on Floppy Disk

Depressing the function key

"F 1" "Save on floppy disk"

calls up a subroutine which contains the results and their codes (file name) already stored on the floppy disk. Input of a freely selectable designation of max. 8 characters and initiation with RETURN results in the last result being written to the floppy disk.

(The total storage space of a new floppy disk is approx. 350 kbytes. Up to the MS-DOS 3.2 the max. number of files, which can be controlled, is limited at approx. 100 measuring results.)

8.2 Loading from Floppy Disk

Depressing the function key

"F 2" "Load from floppy disk"

calls up a subroutine which allows one old result stored on floppy disk to be reloaded into the current memory. It there acts as if the measurement had only just been completed.

This loading process overwrites the current result, i.e., the last measurement which is then no longer available. (If necessary, save on floppy disk beforehand).

The floppy disk drive in the computer is used for loading old measurement results. The flap of the disk drive is opened, the disk inserted into the drive (writing facing the flap) and the flap then closed.

For loading - in acordance with instructions on the monitor -, the cursor control keys "Arrow up" and "Arrow down" are used to page through the file directory and select the page required. The key "s" (for selection) is then pressed. On the monitor appears a marked area, which is positioned over the relevant file name by means of the cursor control keys.

Following initiation with "RETURN", the program automatically loads the measurement results. The program jumps back to the subroutine once the loading procedure has been completed. Depressing the key "F 10" "Back to main menu" displays the main menu on the monitor.

By depressing the key **"F 9" "Present results"**, the program for displaying the measurement results can be called up and the result loaded presented on the monitor.

8.3 Deleting on Floppy Disk

By depressing the function key

"F 4" "Delete on floppy disk"

curves which were previously stored as measurement results can be deleted from the file directory which susbsequently appears.

For deleting - in acordance with instructions on the monitor -, the cursor control keys "Arrow up" and "Arrow down" are used to page through the file directory and select the page required. The key "s" (for selection) is then pressed. On the monitor appears a marked area, which is positioned over the relevant file name by means of the cursor control keys.

Following initiation with "RETURN", the program automatically deletes the measurement results. By pressing <ESC>, the program returns to the paging procedure. Pressing <ESC> once again returns the program to the menu.

If curves which were previously selected as comparative curves (see Point 9 and 12) are inadvertently deleted, the program will display an error message when a cumulative results curve (or RRSB distribution or overlapping) is next called up, since it will be unable to find the comparative curve on the floppy disk.

(To delete everything on a floppy disk, it is easiest simply to reformat the disk.)

8.4 Formatting A New Floppy Disk

By depressing the function key

"F 3" "Format disk"

a program is loaded for formatting new floppy disks.

A warning is output first on the monitor since formatting a floppy disk automatically deletes any programs or results already stored on the disk. (In this way, it is possible, for example, to reformat a disk - in other words to delete the entire disk - if its contents are no longer required.)

The question "Do you really want this (Y/N)?" is answered by entering "Y" and confirming with RETURN. A new floppy disk (or an old floppy disk to be deleted) is then inserted into drive "A" (writing facing flap) and the flap then closed.

After initiating with any desired key, the formatting program is loaded and formatting performed. A question then follows as to whether a further disk is to be formatted. It is only possible to answer "N". This program does not allow the formatting of more than one floppy disk each time it is called up. The program then jumps back to the menu for disk processing.

8.5 Displaying the Floppy Disk Directory

By depressing the function key

"F 5" "Catalog of files",

the contents of the floppy disk in the disk drive are listed on the monitor. (Disk drive closed).

For "paging" through the directory, the cursor control keys "Arrow up" and "Arrow down" are used to select the appropriate page of the file directory. The program is left by pressing the ESC key.

8.6 Creating Reference Files

By depressing the function key

"F6" "Create reference file",

a program corresponding to Point 8.2 is called up which allows two reference files for "Automatic Measurement" (Point 13) to be loaded from the floppy disk to the hard disk. From there, they are "incorporated" upon output of the automatically measured and printed-out results.

9. Loading and Fading In Comparative Curves

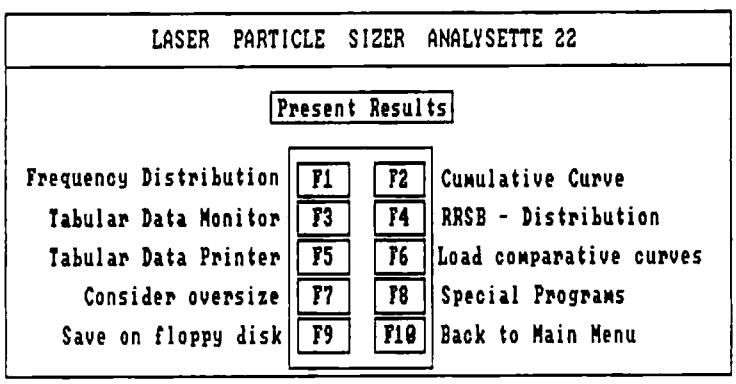
Very positive advantages can be derived from loading additional curves if either calibration substances are to be used for comparative purposes or a range of scatter is to be specified for the measurement by means of upper and lower limits. In this way, "nominal/actual comparisons" are possible and decision criteria displayed immediately on the monitor.

The floppy disk containing the measurement results which are to be loaded as comparative curves is placed in the disk drive. The disk drive is then closed.

In the subroutine "Present results", the function key

"F 6", "Load comparatives"

is used to call up a program for displaying 1, 2 or 3 result curves of preceding measurements - or curves entered from theoretical values - at the same time as the current result after reloading from the floppy disk.



The following options are then offered in the window:

"1) Superimpose one curve on current curve".
"2) Superimpose two curves on current curve".
"3) Superimpose three curves on current curve".
"4) Delete superimposed curves".
"5) Input theoretical curves"
"6) Back to previous program"

The display of existing superimposed curves ends in line 4, and the input of theoretical curves begins in line 6. It is also possible to interrupt the procedure in line 6.

The highlighted cursor is located in the first line. The number of curves to be loaded is selected by moving the cursor up or down using the cursor control keys. The number chosen is confirmed by pressing the RETURN key. A new window then opens on the monitor.

(Curves which were previously called up may have been deleted during the loading process, and may therefore no longer be available.)

Curves which were previously stored on the inserted floppy disk can be loaded from the file directory now visible (which may be several pages long).

For loading - in accordance with instructions on the monitor -, the cursor control keys "Arrow up" and "Arrow down" are used to page through the file directory and locate the page required. The key "s" (selection) is then pressed. In the current window appears a marked area, which is positioned over the relevant file name by means of the cursor control keys.

Following initiation with "RETURN", the program automatically loads this measurement result. The same is true for loading several curves, as selected earlier in the process.

The program automatically jumps back to the subroutine "Present results".

By depressing the keys

"F 2" "Cumulative Curve" or
"F 4" "RRSB - Distribution"

the subsequently loaded curves can be called up on the monitor together with the current measurement result. These curves remain visible until cancelled by deletion in conjunction with calling up a new measurement result as a cumulative curve or RRSB distribution.

The display of these additional curves is deleted by depressing the function key

"F 6" "Load comparatives",

whereby the highlighted cursor is moved to the number 4 and initiated with RETURN.

To input theoretical curves, the highlighted cursor is moved to the number 5 and initiated with RETURN.

Up to 30 pairs of granular size and % frequencies can be entered in the window which then opens.

Following input of the first granular size, the program calculates the corresponding maximum granular sizes. It is important that granular sizes should be entered in ascending order, and that the percentage value for the last granular size must be 100%.

After the final input, "g" (= go) is pressed and the question

"Input OK?" confirmed with "y".

After saving ("y"/"n"), the list of contents is faded in, and the input field for the name to be assigned is opened with <ESC>.
RETURN returns the program to the submenu "Present results".

10. Consideration of Oversize

In the submenu "Present results", depressing the function key

"F 7" "Consider Oversize",

calls up a program whereby proportions of sample removed by sieving before measurement can be reintroduced when displaying the results.

In this way, it is also possible to fully display samples with a percentage of coarse grain (larger than the upper measuring limit); proportions of sample falling outside the measuring limit can thus be included in the same curve pattern.

When this program section is called up, the percentages of the sieved proportions are requested. In accordance with the upper
measuring limit of the last current measurement recalled on the monitor, the program automatically calculates the next possible sieve value. The % proportion determined at sieving is now entered. Up to 4 further sieving values and the corresponding % proportions are then requested. The sieving values are shown in ascending order - the mesh widths being taken in ascending order from the main ISO 565 R20/3 series. (The maximum possible mesh width in this program is 2000 m.)

After entering the percentage proportions of the total sample which were derived from sieving, the program asks if the curves are to be printed out. After entering the corresponding answer (Y/N), the cumulative curve "extended" by the sieved values appears on the monitor, followed by the similarly extended frequency distribution on the printer or monitor. When output at the printer, 5 curve points are also printed out as tabular values. These can be specified beforehand in the **"Initialisation" program** by actuating function key "F6" (see Point 5.1.6).

Finally, the

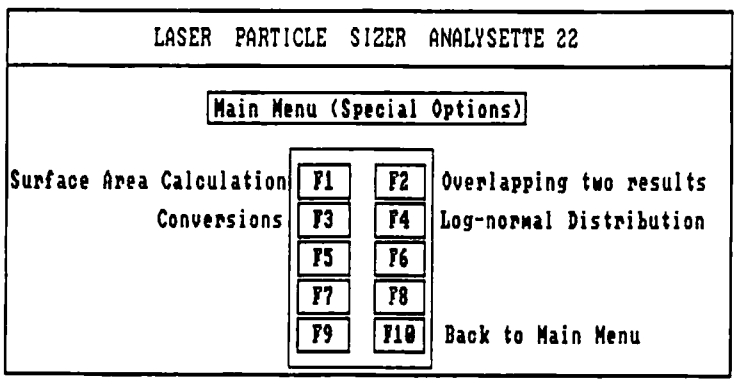
"Present results" menu reappears on the monitor.

11. Special Options

In the submenu "Present results", the function key

"F 8" "Special options"

is used to call up a subroutine for converting and evaluating results.



11.1 Calculating Specific Surface Area

After depressing the function key

"F 1" Surface area calculation

a program is called up which uses the current test result to calculate the (sphere-like) total surface area of the sample. E.g. the monitor displays:

```
Date: 01.07.87 Time: 15.26 Measurement No 17
BCR Standard 66

Surface Area Calculation

  Median Diameter      dm'  =  0.0072   mm
Surface Area (Volume)  Sv   = 83 740.10 cm2 * cm -3
    Area (mass)        Sm   = 31 719.73 cm2 * g -1

      Do you want to calculate Surface Area (mass) ? (y/n)
```

After replying with "y" and then entering the specific density and initiating with RETURN

```
Please enter Density in g/cm3 : 2.64
```

The result appears in a line below the surface area Sv. This is followed by the question of whether a changed shape factor (Standard = 1) is to be input.

```
Calculation done with shape factor = 1
Do you want to change shape factor (y/n) ? e.g. "y" and 1.3

Max. Slope is 88.84 Degrees at 1.00 microns
```

After the calculation has been completed, the maximum slope of the cumulative curve is specified. This program is exited with RETURN. (A copy of the results can be printed out by entering "SHIFT PrtSc" and RETURN.)

11.2 Overlapping Two Results

From the "Special Options" menu, the function key

"F2" Overlapping two results

is used to call up the program for calculating one total curve made up of two matching individual measurements carried out independently of each other.

The measurement in direct succession of a sample with a particle size distribution wider than 3 decades is discussed in detail in section 12. Using the method described, measurements in the coarse particle range and measurements in the fine particle range can be carried out in a combined procedure.

The following information appears on the screen:

```
Overlapping two curves

The cumulative curve will be shown!

Press any key to continue! Press <ESC> to break!
```

This procedure overwrites the last superimposed curve, i.e. where necessary, this latter should first be stored. (See Point 7 and 8.1)

The program is continued after first inserting the floppy disk containing the stored measurement results into disk drive "A". After pressing any key, the disk contents are listed on the monitor.

To load the first measurement curve to be overlapped - in accordance with instructions on the monitor -, the cursor control keys "Arrow up" and "Arrow down" are used to page through the file directory and select the page required. The key "s" (for selection) is then pressed. On the monitor appears a marked area, which is positioned over the relevant file name by means of the cursor control keys. Following initiation with "RETURN", the program automatically loads this measurement result.

(By pressing <ESC>, the program can be returned to the paging procedure; pressing <ESC> once again returns the program to the menu.)

After pressing "RETURN", the program automatically searches for other possible measurement curves in the fine or coarse ranges which correspond to this measurement curve (defined by its measuring cell position during measurement). These are then displayed on the monitor.

(If no matching curve is stored on the floppy disk, the program breaks down and must be restarted by entering "sizerexe")

The second measurement curve is loaded following the same procedure as was used to select and load the first.

After loading the second curve through initiation with RETURN, the superimposed curve of both measurements is shown on the monitor in a coordinate network of 0.1 µm to 1000 µm as one curve.

This new result is stored in the computer until it is overwritten by a new superimposed curve. (Its name is automatically assigned the extension ".OVL".)

This program section is left by pressing "RETURN".

The superimposed curve can also be subsequently presented in a different form, or can be saved on floppy disk:

From the main menu, the function key

"F 10" "Overlapping"

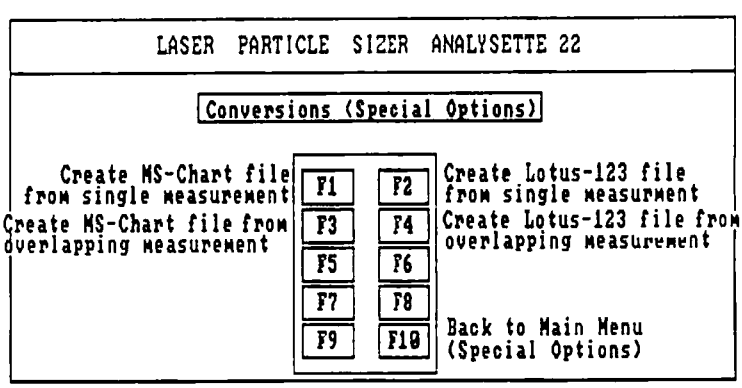
is used to call up "Main Menu (Overlapping)". In this subroutine, superimposed curves can also be displayed in tabular form or as frequency distributions. (See Point 12).

11.3 Converting Results

From the "Special options" menu, the function key

"F 3" "Conversions"

is used to call up the program for converting the format of a result stored on floppy disk. This converts and renames the results file stored on the disk so that it can be read and further processed using MicroSoft-Chart™ and the Lotus 123™ software.



The following function keys are used for converting and renaming files:

"F 1" Measurement results from individual measurements for MS-Chart™,
"F 3" Measurement results from overlapping two measurements for MS-Chart™,
"F 2" Measurement results from individual measurements for Lotus 123™
and
"F 4" Measurement results from overlapping two curves for Lotus 123™.

Before pressing a function key, the floppy disk containing the appropriate stored measurement results must be inserted into disk drive "A". (Writing facing the flap; close disk drive.)

After selecting a function key, all the measurement results stored on the floppy disk are displayed on the monitor.

To load the first measurement curve intended for conversion - in accordance with instructions on the monitor -, the cursor control keys "Arrow up" and "Arrow down" are used to page through the file directory and select the page required. The key "s" (for selection) is then pressed. On the monitor appears a marked area, which is positioned over the relevant file name by means of the cursor control keys. Following initiation with "RETURN", the program automatically converts this measurement. The new, converted results file can be freely named; conversions with MS-Chart™ are assigned the extension ".CHA", and conversions with LOTUS 1-2-3™ the extension ".WKS".

11.4 Log - Normal Distribution

From the "Special options" menu, the function key

"F 4" "Log - Normal distribution"

is used to call up the program for the presentation of results in the coordinate network of a logarithmic normal distribution.

A particular feature of this program is that

the volume-related cumulative curve,
the particle figure %,
the surface area - % and
the specific surface area (m^2/dm^3)

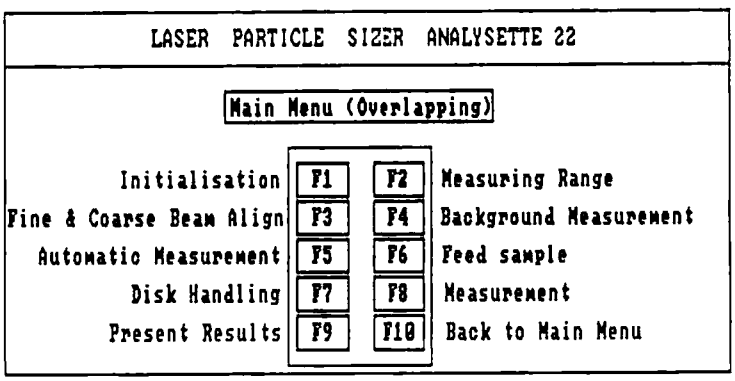
are displayed simultaneously in the coordinate network in relation to granular size.

12. Overlapping Measurement

From the main menu, the function key

"F 10" "Overlapping"

can be used to call up the "Main Menu (Overlapping)". Within this virtually independent subroutine, very broad particle size distributions can be measured in a rational way, making optimum use of the equipment's technical capabilities.



The "Main Menu (Overlapping)" is constructed according to the same principle as the unit's main menu - it is operated in a similar way and its use therefore requires no additional training.

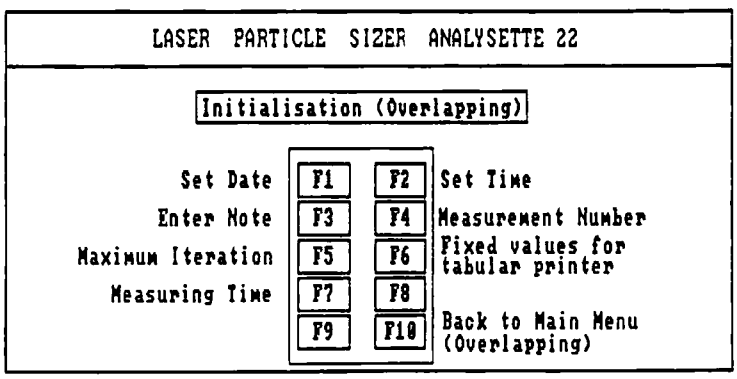
12.1 Input of Parameters and Remarks

In the "Main Menu (Overlapping)", depress function key

"F 1" to call up "Initialisation".

Before measurements are begun, the date, time, parameters for the documentation, consecutive number of the measurements to be performed and variations regarding the type of calculation can be input with this submenu.

(These data are also output with each result.)



12.1.1 Set Date

By pressing the function key

"F 1" "Set Date",

the current date can be entered.
(Not necessary where the computer has an integrated calendar and clock)

The line "Last Date was:..." shows the last date entered. When a number is input for "Enter Day": (initiation with RETURN), a new date is written over the old one. The procedure is the same for the month (Enter Month:) and the year (Enter Year:). The date already shown in "Last Date was:..." is adopted by the computer if initiated with "RETURN".

The program disregards any date specifications (e.g. 32.13.1884) which are obviously "incorrect" and issues the note "wrong date". The date then has to be input again.

12.1.2 Set Time

By pressing the function key

"F 2" "Set Time",

the current time can be entered.
(Not necessary where the computer has an integrated calendar and clock)

The current time is shown in the bottom line (Actual Time is:...). The minutes and hours shown on the computer clock can be changed by entering new values. It is also possible, without entering new times, to adopt the time currently shown by initiating with RETURN. The program then returns to the subroutine.

12.1.3 Enter Notes

By pressing the function key

"F 3" "Enter Note",

notes on the measurement can be entered.

The last note is displayed in the bottom line and can be adopted by depressing the RETURN key. By inputting a new note (not longer than 40 characters; only digits and upper-case and lower- case letters), this is overwritten and stored by the computer after initiation with RETURN. The menu of the subroutine is then faded back onto the monitor.

12.1.4 Measurement Number

By pressing the function key

"F 4" "Measurement Number",

the start number of the next measurement can be entered.

The number entered (e.g. 1) is stored by the computer after initiation with RETURN, is automatically incremented for each subsequent measurement and is printed out in the measurement logs. In this way, measurements can be differentiated in the log even if they have been given the same notes. After RETURN the program jumps back to the submenu.

12.1.5 Maximum Iteration

By pressing the function key

"F 5" "Maximum Iteration",

the criteria for interrupting the calculation of the particle distribution can be specified.

This program can be used to alter the criteria for interrupting the calculation of particle size distribution. Normally, calculation is interrupted either when 15 iteration steps have been calculated or when the deviations from optimally matched values are smaller than 0.002.

This limit value can be freely selected within the range of 0.0004 to 0.01. The closer the particle size distribution of the sample corresponds to a simple mathematical function (e.g. a Gaussian distribution), the lower (e.g. 0.001) the limit value can be set.

12.1.6 Selection of Fixed Values (% - $_{/}$um) for Tabular Printer

By pressing the function key

"F 6" "Fixed values for tabular printer (% - $_{/}$um)",

fixed points for results output can be selected.

This subroutine can be used to select up to five fixed values in advance. It is possible to freely select either the percentages for particular particle sizes or the particle sizes for particular percentages. This is particularly useful where specific percentages or particle sizes are required for the evaluation of the results.

Since a spline function is used to calculate the interim values, any percentage or particle size can be entered - e.g. inputs such as 10%, 20%, 50%, 63.2% and 90%. The corresponding particle sizes are then calculated and printed out in a small table when the tabular values are output. (See example on p. 25)

12.1.7 Measuring Time

By pressing the function key

"F 7" "Measuring time",

the time for the measurement of particle size distribution can be set.

This program can be used to alter the actual measuring time (number of individual system measurements while the measurement of particle size distribution of one sample is being determined).

By changing the multiplication factor (standard = 1), the measuring time can be extended by a factor of up to 100. If the maximum factor of 100 is entered, the time taken to measure a sample will be 20 minutes (12-MHz clock frequency of the computer).

All the data and notes entered in these subroutines ("Initialisation" (Overlapping)) are stored until new values are entered.

By pressing the function key

"F 10" "Back to main menu",

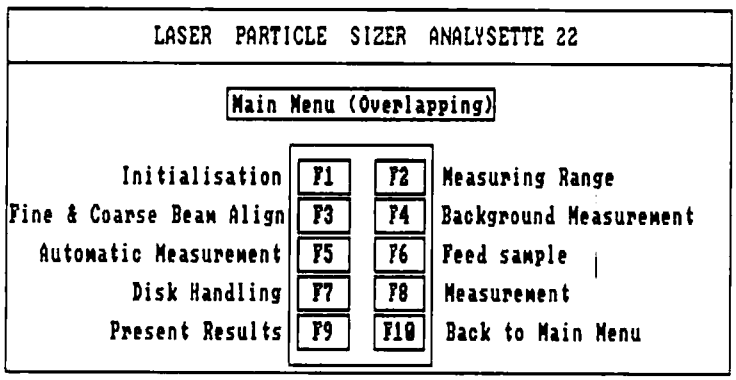
the program returns to the main menu (Overlapping).

12.2 Selecting and Adjusting the Measuring Range

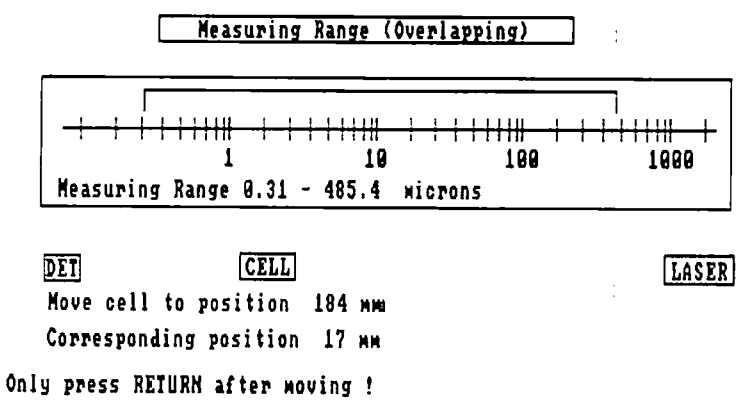
In the Main Menu (Overlapping), pressing the function key

"F 2" calls up the "Measuring range"

subroutine for entering the desired measuring range.



A symbolic representation of the full range is then displayed on the screen (more than 3 decades). A bracket in the upper section of the image shows the current measuring range. This measuring range is also displayed as a numerical value in microns (lowest limit value of the smallest measuring channel or upper limit of the largest measuring channel) in the line below the scale.



In each case, the measuring range encompasses around 3.5 decades and can be continuously selected and adjusted in as many individual steps as required by simply shifting the measuring cell. The smallest range covers the particle sizes 0.16 µm to 250 µm, the largest range 0.77 µm to 1166 µm (lower and upper class limits).

By actuating the control keys for the cursor, the measuring range is adjusted in accordance with the symbolic representation. Every time the cursor control keys are actuated (left or right), the bracket (and therefore the measuring range) in the display moves left or right. (If it is to be moved a larger distance, the jump interval for the bracket can be increased by depressing the right-hand "SHIFT" and cursor control keys simultaneously, thereby allowing the set measuring range to be changed more quickly.)

The required position of the measuring cell for the selected measuring range is displayed at the bottom of the monitor, e.g.:

```
"Set cell distance from detector to ... mm"
```

It is essential that the position specified at this point agrees with the actual position of the measuring cell. Otherwise the subsequent measurement and calculation of the particle size distribution is worthless.

In order to move the measuring cell to the position prescribed by the computer, the unit is opened and the cell moved by hand so that the indicator attached to the cell points to the number on the measuring strip which agrees with the number read off the monitor. (The accuracy required in setting the position is ± 1 mm.)

For safety's sake, a question is faded onto the monitor after this program section has been left which can only be answered with "Y". It is possible to jump back to the program again by entering "ESC".

When measuring with the dry dispersion unit, it is only possible to select position 442 mm for measuring the coarse range, and position 42 mm for measuring the fine range. The total measuring range for dry measurement in the free jet is thus 0.77 m to 1166 m.

12.3 Background Measurement

A background measurement must be performed before every measurement in order to eliminate the influence of the test liquid when performing measurements in suspension. During this process, any slight contaminations detected during preceding measurements are recorded and their influence on the current result eliminated.

When performing measurements in supension in direct succession without changing the measuring range, and when measuring with the dry dispersion unit, no "intermediate" background measurement is necessary if the background is not expected to change.

To expand the measuring range, two measurements with two different measuring ranges are carried out in direct succession. The two background measurements thereby required are carried out by the program in direct succession.

Approximately 6 cm of very clear test liquid is poured into the ultrasonic bath of the dispersion unit and the circulating pump switched on. After the pump has been running for a short time, it is switched off briefly and, after some 10 secs., is switched on again. This procedure is used for bleeding the pump system and should be repeated as many times as necessary until no more air bubbles enter the bath from the inlet.

(The beam alignment can be checked (see 4.3) after filling the ultrasonic bath with clear liquid. However, adjustment is only necessary in a very small number of cases.)

For background measurements with the dry dispersion unit, no further preparations are necessary - only the supply of pure compressed air needs to be switched on at the dispersion unit.

When the measuring cell has been set to the coarse range (or set to 442 for dry measurements), the function key

"F 4" "Background measurement"

in the Main Menu (Overlapping) is pressed to start the background measurement in the setting for measuring the coarse percentage.

Directly following this, the intensities of the 31 coarse range channels are displayed symbolically on the monitor.

The image is cleared automatically after a few seconds. The data obtained during this measurement and thus the characteristics of the test liquid or background are stored in the computer for later evaluation.

The monitor requests the movement of the measuring cell (or nozzle holder) to the position for measurements in the fine range. After this movement of the cell has been confirmed by pressing "y", the second background measurement begins automatically. These values are also stored.

(Background measurement values are retained even when the unit is switched off, and are taken as the basis for all subsequent measurement calculations. The values of the "old" measurement are only overwritten - and thereby lost - when a new background measurement is performed.)

The background measurement can be interrupted prematurely by depressing the RETURN key. The program then jumps back to the main menu and the values from an earlier background measurement which are stored in the computer are retained unchanged.

This interruption may be necessary, if, for example, the background measurement is selected unintentionally - i.e. if the values measured earlier must not be overwritten.

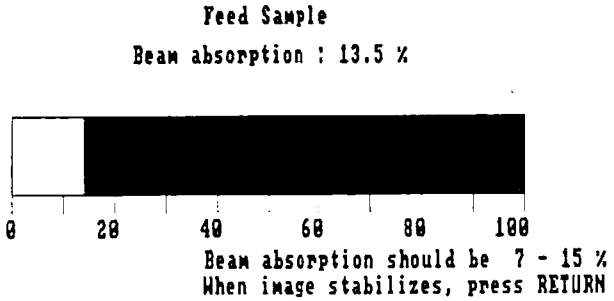
12.4 Feeding of Sample with Liquid Dispersion Unit

In the liquid dispersion unit, the sample is added to the test liquid either dry or in the form of a suspension after being dispersed first in an external process (prior to this, the measuring range is set, see Point 12.2, and a "background measurement" performed, see Point 12.3; circulation pump and the agitator are switched on).

The quantity of sample fed into the ultrasonic bath can be checked by depressing the function key

"F 6" in the main menu to call up the "Feed sample" subroutine.

A bar chart then appears on the monitor which symbolically indicates the extinction of the laser beam.



A small quantity of the sample to be examined (approx. 0.5 - 1 g) is now fed into the ultrasonic bath and the latter then switched on (if advantageous for dispersion).

Depending on the dispersibility of the sample, it is either fed directly into the ultrasonic bath in dry form using a spatula or is first prepared in the test liquid in a separate dispersion process and is then added to the ultrasonic bath in the form of a suspension.

The quantity added is displayed in relative values on the computer screen. (No masses or quantities need therefore be measured out in advance.) The bright field of the screen (shown black in the figure above) becomes smaller as the quantity increases.

The measurement can begin as soon as a stable dispersion has been achieved after a short time by means of the ultrasonic effect and the agitator. (Only small deviations are displayed in the most favourable measuring range between approx. 7 and 15 % beam absorption.)

If the sample contains a relatively large component of fine-grained material in the range 1-10 m, the beam absorption percentage should lie in the lower range, i.e. at around 10 %. If there is a high component of coarse grain material without fine grain component, the measuring result is still acceptable, even for concentrations up to approx. 25 %.

RETURN brings the main menu back onto the monitor.

12.5 Feeding of Sample with the Solids Dispersion Unit

Particle size distributions from 1 to approx. 1160 µm can be measured with the solids dispersion unit.

For "dry" measurement with the solids dispersion unit, the sample is filled into the dispersion unit.

The unit is opened, return travel activated by the "STOP/DOWN" key and, after the lower support plate has lowered, the cylinder securing plate and the solids cylinder are lifted out from below.

In order to generate a flow of particles which is as homogenous as possible, the solids cylinder must be filled uniformly.

Depending on the characteristics of the sample, it is filled into the solids container centimeter by centimeter, and compressed with the aid of a stopper. The weight of the stopper alone is sufficient to compact the sample.

The filled solids container is inserted (groove facing the left) and secured by the cylinder securing plate.

After depressing the "Air" and "Forwards" keys, the piston is moved into the solids cylinder at the speed set on the rotary knob. If the compressed solids come into contact with the rotating brush, this brush picks up a certain quantity of solids, the latter then being transported into the measuring unit by the flow of compressed air.

Caution:

Before switching on the compressed air, the dust extractor must be inserted into the rear panel of the measuring unit and put into operation.

12.6 Measuring Particle Size Distribution

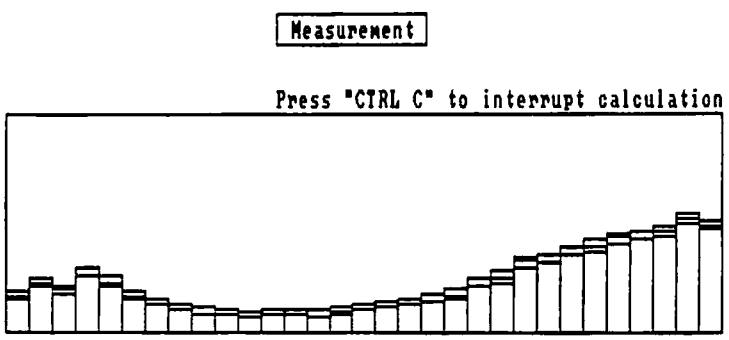
Before each measurement with the liquid dispersion unit, the measuring system must be bled again by switching off the pump and then reactivating it.

Here, too, two measurements with two different measuring ranges are carried out in direct succession. On the monitor, the program displays the positions of the measuring cell and automatically carries out both measurements in direct succession.

In the Main Menu (Overlapping), the function key

"F 8" is depressed to call up the "Measurement" program.

Immediately after this, the relative intensities of the 31 measuring channels of fine-range measurement are displayed on the monitor in symbolic form, in a similar way to the background measurement. (The cell is thus NOT moved before the start of measurement - it remains in the same position as in the second half of the background measurement.)



The image is automatically extinguished after a few seconds. The measurement values determined during this measurement are stored in the computer for later evaluation.

The monitor requests that the measuring cell (or nozzle holder) be moved to the position for coarse-range measurements. After this movement of the cell has been confirmed by pressing "y", the second background measurement begins automatically. These values are also stored.

(Measurement values are retained even when the unit is switched off, and are taken as the basis for all subsequent calculations and representations of results. The values of the "old" measurement are only overwritten - and thereby lost - when a new measurement is performed.)

The measurement can be interrupted prematurely by depressing the RETURN key. The program then jumps back to the main menu and the values from an earlier measurement which are stored in the computer are retained unchanged.

This interruption may be necessary, if, for example, the measurement is selected unintentionally - i.e. if the values measured earlier must not be overwritten.

After a few seconds, the text "wait, program running" appears above the bar chart, indicating that the measurement has been completed and that mathematical evaluation of the measurement has begun. When measuring with the solids dispersion unit, the dosing piston feed can be deactivated at this point (depress key "Stop/Down"). The measurement results remain stored when the computer is switched off - even if they have not been stored on floppy disk. (Results can only be deleted by overwriting with a new measurement.)

The main menu reappears on the monitor.

If a background measurement has not been performed before the measurement, a note appears on the monitor: "Measure background first". In this case, this background measurement must be selected in the Main Menu (Overlapping) (see Point 12.3); measurements with the liquid dispersion unit hereby first require the ultrasonic bath to be reflushed and the measuring cell refilled with clear test liquid.

12.7 Flushing the Liquid Dispersion Unit

As soon as the measurement itself has been completed, the measuring cell must be flushed. The test sample should not be left unnecessarily in the supply unit - and thereby in the test circuit as a whole - over any long period of time.

Under no circumstances may the conveyor pump of the liquid dispersion unit be switched off when there is a test sample in the test circuit.

The medium in the liquid circuit comes to rest when the conveyor pump is switched off. The particles in the liquid then settle, possibly resulting in blockages or particles being deposited in the hose system.

If the "IN" hose connection is linked up to a connection on the supply system, both ball valves are turned so that the tips of their rotary toggles point outwards. Turning the rear ball valve drains the test circuit through the hose which is fitted to the rearmost hose nipple. The front ball valve allows clean, fresh
flushing liquid to enter through the hose fitted to the foremost nipple.

If the flushing liquid cannot be supplied via a hose for any reason, the front ball valve remains in the same position with the tip of the toggle pointing to the rear (inwards) and the flushing liquid enters the ultrasonic bath directly from above.

In each case, it must be ensured that the level of the flushing liquid in the ultrasonic bath is no higher than

approx. 2 cm below the upper rim.

The effect of the flushing operation can be easily monitored by means of the program

"F 6" "Feed sample",
since there is practically no beam absorption with clear liquid.

(When the value of "0%" absorption is obtained in flushing, this corresponds to the value measured with clear liquid in the last background zero measurement. When performing a background measurement, absorption is set at "0". When the light-coloured bar fills almost the entire field, the measuring cell is as clean as it was for the last background measurement, and the next measuring cycle can be performed.)

The windows of the measuring cell must be checked if no satisfactory result is obtained even after a long period of flushing. Any dust sticking to the outer side of the windows may only be brushed away very carefully using a very fine hair pencil (optician quality). Any particles sticking to the inside of the windows can only be removed after opening the measuring cell (see Point 14.1 "Cleaning the measuring cell").

A further way of checking is possible after calling up the program section "Fine Beam Alignment". The height of the lines in the graphic display indicate the contamination still present. (Coarse component on left-hand side, fine component on right-hand side. See also Point 4.1.2)

12.8 Cleaning the Solids Dispersion Unit

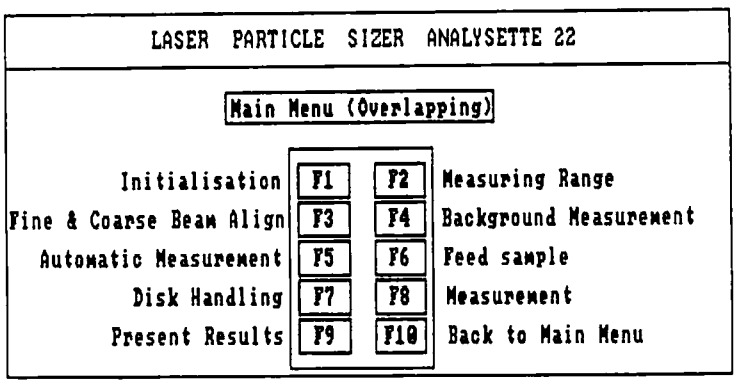
After completing the actual measurement itself (i.e. when the message "wait program running..." appears on the monitor), it is possible to stop the supply of new solids by depressing the "Stop/Down" key on the solids dispersion unit.

For as long as the compressed air remains activated, the rotating brush is blown out and is thereby cleaned automatically. The hose connection and the exhaust nozzle in the test unit also clean themselves automatically. The extractor, which is still active up until this point, removes all remaining traces of the sample.

Blowing out with compressed air is sufficient to clean the sample cylinder before adding the next sample. After unscrewing the right-hand flange, the rotating brush can be removed with the
help of the threaded pin (thread M4), and also blown out. The brush must not be damaged during cleaning (its outer edge is specially finished - any loose or detached bristles must be removed). After reinserting the brush, the flange must be pushed in as far as it will go and screwed in securely at the correct angle.

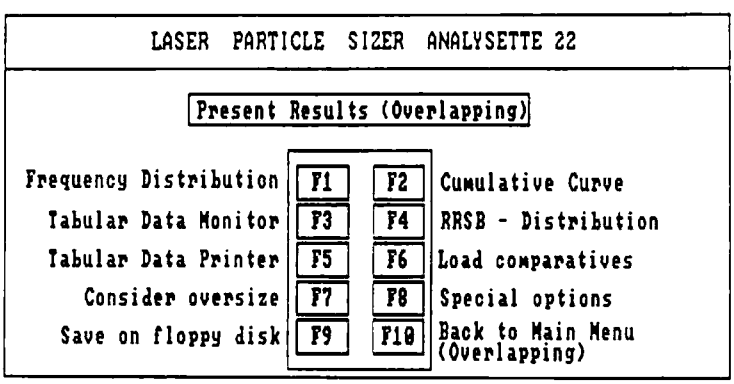
12.9 Presenting Measurement Results

In the Main Menu (Overlapping),



the function key

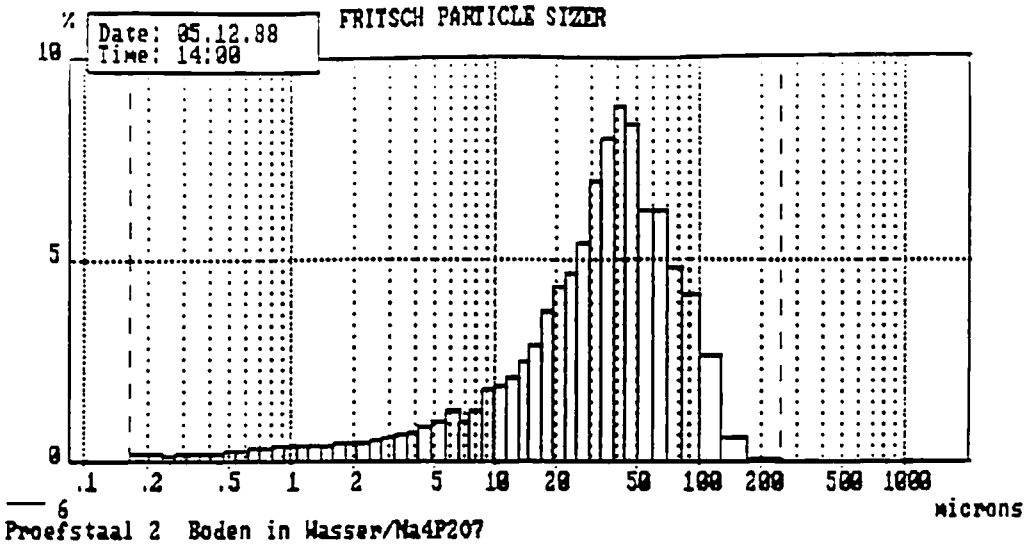
"F 9" is used to call up the submenu **"Present results".**



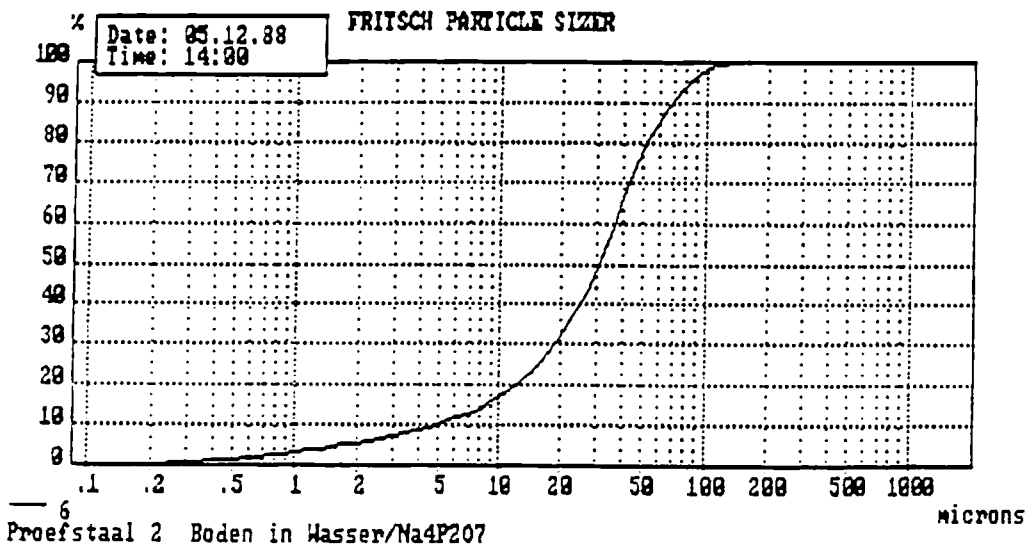
By activating certain function keys in this menu, it is possible to select the manner in which the results are presented. The results then appear immediately on the monitor or at the printer.

"F 1": Frequency distribution
"F 2": Cumulative curve
"F 3": Tabular data on the monitor
"F 4": Cumulative curve in log/log network (RRSB distribution)
"F 5": Tabular data as printout
"F 6": Loading of comparative curves for presentation with current result
"F 7": Consideration of sieved values
"F 8": Special options
"F 9": Saving the current measurement results
"F10": Return to main menu

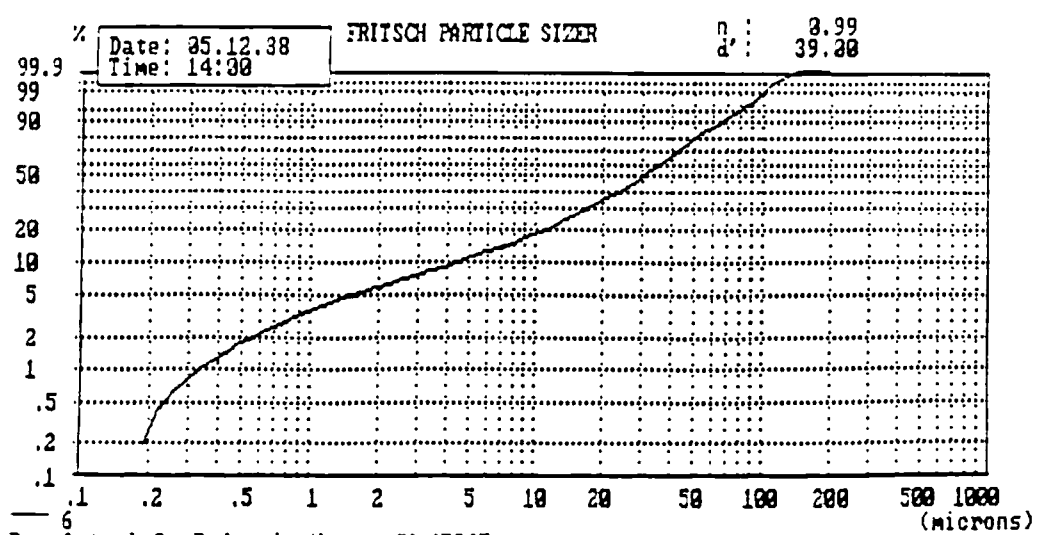
A copy of the screen contents is output on the printer by simultaneously depressing the SHIFT and PRINTSCREEN keys (identified by upwards-pointing arrow and PrtSc).



Function key "F 1": Frequency distribution



Function key "F 2: Cumulative curve



Function key "F 4": Cumulative curve in log/log network (RRSB distribution)

********* FRITSCH PARTICLE SIZER *********
*** A N A L Y S E T T E 2 2 ***

Parameters :

Measure num.: 6 Date : 05.12.88 Time : 14:00
Proefstaal 2 Boden in Wasser/Na4P2O7

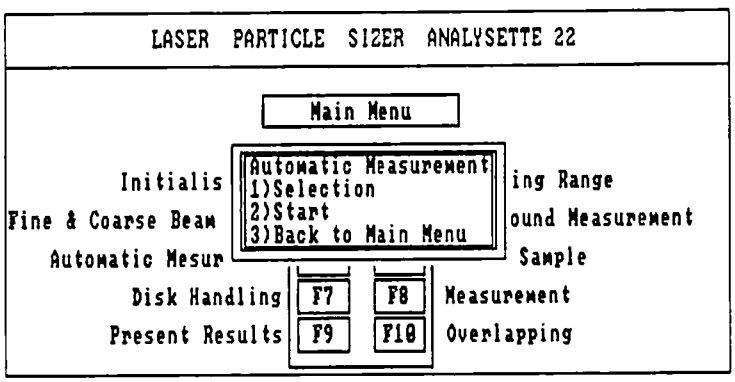
Sizeclass (micron) Low	Average	High	Freq.(%)	Cum.freq.(%)
0.16	0.19	0.21	0.19	0.19
0.21	0.22	0.24	0.19	0.38
0.24	0.25	0.27	0.16	0.53
0.27	0.29	0.31	0.19	0.72
0.31	0.33	0.36	0.19	0.91
0.36	0.38	0.41	0.22	1.13
0.41	0.44	0.47	0.22	1.35
0.47	0.50	0.54	0.28	1.63
0.54	0.58	0.62	0.28	1.92
0.62	0.66	0.71	0.31	2.23
0.71	0.76	0.81	0.35	2.57
0.81	0.87	0.93	0.41	2.98
0.93	0.99	1.07	0.41	3.39
1.07	1.14	1.22	0.41	3.80
1.22	1.31	1.40	0.44	4.24
1.40	1.50	1.61	0.44	4.68
1.61	1.71	1.84	0.47	5.15
1.84	1.96	2.11	0.47	5.62
2.11	2.25	2.41	0.50	6.12
2.41	2.58	2.76	0.57	6.69
2.76	2.95	3.16	0.63	7.32
3.16	3.38	3.63	0.69	8.01
3.63	3.89	4.18	0.75	8.76
4.18	4.47	4.83	0.88	9.64
4.83	5.19	5.63	1.00	10.64
5.63	6.07	6.61	1.26	11.90
6.52	6.96	7.47	1.00	12.90
7.47	7.98	8.56	1.30	14.20
8.56	9.14	9.82	1.80	16.00
9.82	10.49	11.25	1.90	17.90
11.25	12.02	12.90	2.10	20.00
12.90	13.79	14.79	2.50	22.50
14.79	15.79	16.95	2.90	25.40
16.95	18.10	19.42	3.70	29.10
19.42	20.74	22.24	4.30	33.40
22.24	23.73	25.48	4.60	38.00
25.48	27.22	29.17	5.40	43.40
29.17	31.12	33.40	6.90	50.30
33.40	35.68	38.35	8.00	58.30
38.35	41.02	44.12	8.80	67.10
44.12	47.23	51.00	8.30	75.40
51.00	54.77	59.43	6.20	81.60
59.43	64.10	69.82	6.20	87.80
69.82	75.54	83.14	4.80	92.60
83.14	90.74	100.91	4.10	96.70
100.91	111.08	126.63	2.60	99.30
126.63	142.18	169.29	0.60	99.90
169.29	196.40	250.62	0.10	100.00

13. Automatic Sequence of Measurements

It is also possible to automatically link up the sequence of measurement, evaluation and output of results and storage of the measurement data in a special subroutine.

This subroutine for series measurement or for measurements performed according to a standardized sequence is called up from the Main Menu by pressing the function key

"F 5" "Automatic measurement":



This opens a window featuring a highlighted area which can be moved to the selected field by means of the cursor control keys. If positioned on the first line ((1) Selection)), and initiated with RETURN, another window opens; this window features questions regarding the form of the automatic measurement which have to be answered with ("y"/"n").

It is here possible to decide, e.g., whether a background measurement is needed for every measurement, whether a measurement should be stored on floppy disk under a specific name, and then - in the next window - how the results should be presented on the monitor and/or at the printer.

It is also possible to decide whether a comparative curve should be sought for the results curve, and whether this should be included with every results presentation.

These comparative curves are called up from an inserted floppy disk (with stored results) using "F 6" "Create reference files" (Point 8.6) in the "Disk handling" menu. This subroutine is used to copy the curves onto the hard disk. From the hard disk they are then "incorporated" into an automatic measurement at the appropriate moment during results presentation.

The program sequences thus determined are then started by selecting the 2nd line ((2) Start)). The entire measurement program then runs automatically.

If a further automatic measurement is to follow, "Automatic Measurement" is again selected via function key "F 5", and the measurement sequence directly restarted with the second line. The sequence last chosen will remain valid - and can be started in this way - until a new sequence is selected.

The manipulations required, e.g. for cleaning or flushing the ultrasonic bath and the measuring cell or for releasing the measurement after input of the sample, are performed by the program.

If background measurement is required, a sequence used for controlling flushing is called up before the program is run again. This sequence is illustrated in a similar way to "Feed sample". Flushing should be continued until the beam absorption lies between 0 - 1%, or until the light part the beam fills the whole field.

Of course, it is also possible to suppress the display of any result on the monitor or, for example, to output only the measurement parameters and the tabular data to a printer; the storage can also be freely selected.

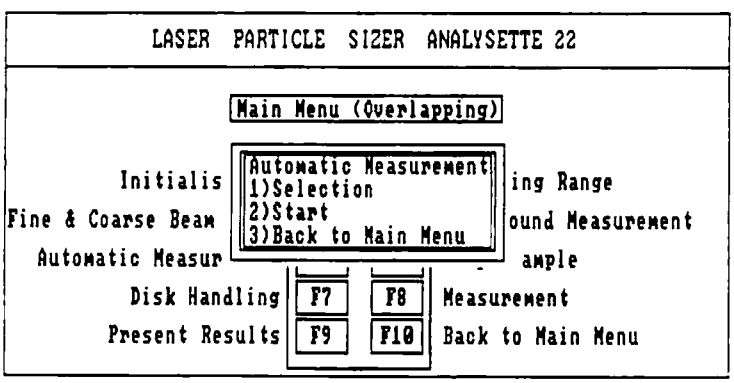
The code facilitating "relocation" of a specific result -consisting of any 5 characters identifying the measurement series - is automatically assigned a consecutive measurement number.

Since the computer's own clock automatically records the time and date of the measurement, a clear allocation of the measurement to a result can also be ensured at a later date. This result can also be loaded back from the save disk and evaluated at a very much later date.

In "Automatic measurement" in the **Main Menu (Overlapping)**,

the same procedure applies. The programs are essentially identical. The only deviation from the procedure described above is the moving of the measuring cell which is necessary within the background measurement and during measurement itself.

The loading of reference files in the "Disk handling" subroutine in the Main Menu (Overlapping) also follows the same procedure.



14. Maintenance

14.1 Cleaning the Measuring Cell

It is generally sufficient to rinse the cell with clear liquid (see Point 6.5). Depending on the characteristics of the measuring sample, however, it may also be necessary over the course of time to clean the inside of the measuring cell. This is necessary, for example, when a large number of small light spots can be seen on the inside of the windows when the measuring cell is right over at the left-hand side (with laser beam activated) and these spots cannot be removed by repeated rinsing.

The laser must be deactivated for disassembling the measuring cell.

After the measuring unit is opened, the two bolts on the right- hand side are undone using a 5 mm Allen key and the cell is lifted out to the front. It is advisable not to detach the hoses until the measuring cell has been lifted out, since this prevents any dirt from entering the measuring unit.

Before disassembling the measuring cell and cleaning the windows, flow disk and sealing rings, a washing bottle with distilled water and special "lens cleaning paper" is prepared on a clean bench.

The 4 mm Allen key is used to undo the 4 bolts holding together the two halves of the measuring cell. One half of the cell is then carefully lifted off.

Care should be taken not to touch the windows (plane-parallel plates) and they must also not be allowed to fall out!!

After the two open halves of the measuring cell have been placed next to each other on clean paper, the flow disk is lifted off very carefully and placed to one side and the windows are carefully lifted out and put down on the special paper.

Great care must be taken in cleaning the windows. They should only be touched along the edge.

The windows are cleaned on both sides as follows:

The windows are rinsed with the washing bottle using distilled water until all dirt has been removed. Special paper is then placed on the upper side of the window and wetted with the distilled water from the washing bottle so that the paper clings to the glass surface. The window is "wiped off" by drawing off the paper parallel to the surface without pressure being exerted onto the glass by the hand. This operation may have to be repeated with clean paper until all traces of dirt have been removed.

The flow disk must be handled very carefully!

It has been manufactured plane-parallel to extremely low tolerance values and must not be placed under any mechanical stress at all. The disk cannot be used if it is bent in any way.

The flow disk can be rinsed under running water. Any stubborn particles sticking to the disk should be removed very carefully using a soft brush.

The two halves of the measuring cell and the sealing rings can be rinsed under running, distilled water and then wiped off and dried using soft, lint-free paper.

The measuring cell is assembled in the reverse sequence of steps to disassembly. After the sealing rings and the windows (reflective blue sides facing outwards) have been inserted on each side, the flow disk is fitted onto the two pins so that the flow ducts point to the halves with the hose connections. The measuring cell is then carefully closed by fitting the two halves together and the bolts carefully tightened "crosswise".

It must be ensured that the two halves of the measuring cell are "closed" with the four screws to the same extent. The flow disk lying between the two windows holds the windows exactly parallel. The sealing rings ensure that the window is pressed against the flow disk with no space in-between. Dirt on the windows or disk will adversely affect the parallel position of the windows. Moving the measuring cell to adjust the measuring ranges will make the windows unparallel, and this will upset the alignment of the laser beam.

It is also advisable here to fit and secure the hoses before the measuring cell is screwed in. (Note the direction of flow: liquid must enter the measuring cell from below).

14.2 Conversion for Measurement with Liquid and Dry Dispersion

The measuring unit of the "analysette 22" can be converted from measurement with suspensions (liquid dispersion unit) to measurement with the dry dispersion unit (or vice versa) by a few simple operations.

As with all operations in the test unit (except adjustment of the laser beam), the laser beam source first has to be deactivated. With the measuring unit open, the measuring cell and the cell mount are unscrewed from the linear guide on the rear, upper guide rod.

Two screws securing the graduation mount are then removed from the side, on the left of the cell mount. The fastening bolts between the cell mount and linear guide can be reached from above (4 mm Allen key). The fact that the thread is in the cell mount means that the bolts need not be removed but can remain in the drill holes until the support plate for the dispersion nozzle is screwed on securely.

After the measuring cell and mount have been lifted out, the hoses are unscrewed from the cell and are pulled out of the test unit from the rear.

The dispersion nozzle is then screwed securely to the linear guide whose feed hoses are run through the rear panel of the test unit and are fitted onto the dispersion nozzle so that the hose clamped to the upper section of the dry dispersion unit is secured centrally to the nozzle and the compressed air hose clamped to the bottom is secured to the side of the nozzle.

Using its two screws, the graduation mount is then screwed securely to the support plate of the dispersion nozzle.

The extraction hose secured to the mount for the dispersion nozzle is run between the front guide rod and the housing at the front of the test unit (the hose must not be twisted or bent). The flange located at its free end is inserted into the bore on the left-hand side of the rear panel and is then screw-fitted. (This bore is covered by a plate when the measurement is performed in suspension.)

The hose is run to the left between the front guide rod and housing and in front of the optics flange to the rear panel. The hose for connecting a dust extractor is inserted from outside into the outer opening of the hose flange
(order no. 43.902.00).

Conversion from measurement with dry dispersion unit to measurement with suspension is performed in the reverse sequence of steps.

14.3 Checking the Amplifiers

Located immediately to the right of the sensor in the test unit is a PCB which accommodates the preamplifiers. The operational amplifiers accommodated here on stable bases are part of the group of components pretested during continuous testing and selected according to the stringent guidelines of the MIL-SPECS.

A special program has been created in the computer to check these components and indicates the starting values of all 31 test channels and of the diode housed in the center behind the sensor.

To call up this control program it is necessary to exit the main test program of the "analysette 22". To do so, press function key

"F 1" "Initialisation"

in the main menu, and then press function key

"F 9" "Exit Program".

The program is exited by entering "Y" in reply to the question whether this is really desired.

The character C> indicates that the system level has been called up.

The subdirectory "SERVICE" is now called up by making the following input and by selecting the special program from this subdirectory:

C>cd\service <RETURN>
C>DMS23012 <RETURN>

A numerical matrix appears on the screen after a short time. When the laser beam and dispersion unit are switched on, these values provide the starting values of the signal for each channel amplified in the preamplifier. Beginning with the central diode - first value: first line and column - the values of the individual channels are specified line by line (counted from inside to outside in the sensor).

```
ADC DMS230 / MUX DMS 233 / * SCAN OVER 2 MUXE TOTAL 32 CHANNELS
CHANNELS ARE SHOWN FROM INSIDE TO OUTSIDE


-2.4800 VOLT  -0.0425 VOLT -0.0050 VOLT -0.0150 VOLT
-0.0175 VOLT  -0.0200 VOLT -0.0150 VOLT -0.0200 VOLT
-0.0200 VOLT  -0.0225 VOLT -0.0275 VOLT -0.0350 VOLT
-0.0425 VOLT  -0.0650 VOLT -0.0900 VOLT -0.0800 VOLT
-0.0650 VOLT  -0.0650 VOLT -0.0900 VOLT -0.0800 VOLT
-0.1050 VOLT  -0.0925 VOLT -0.1200 VOLT -0.1000 VOLT
-0.1375 VOLT  -0.1250 VOLT -0.1450 VOLT -0.1300 VOLT
-0.1775 VOLT  -0.1350 VOLT -0.2075 VOLT -0.0875 VOLT
```

The numbers of this matrix are constantly rewritten. The deviations are only slight and the values are all negative.

If the measuring cell is clean, almost no scattered light reaches the outer areas of the sensor. Consequently, the intensities issued from these areas (voltages in VOLTS) are also small. They should correspond more or less to the values given as examples above.

If an amplifier fails, the corresponding value is either very small (a few millivolts), i.e. the amplifier does not function or does not amplify, or the value is very large (-5.12 VOLTS), i.e. the amplifier is switched through or its supply voltage $\pm$15 VOLT is available at the output.

The following table shows, for each channel, the related position on the connector of the printed circuit board (lower connector). The enclosed circuit diagram "Circuit Diagram for Preamplifiers" (page 50) allows the operational amplifiers to be identified whose values in this program were out of the ordinary.

Channel	Pin	Channel	Pin	Channel	Pin	Channel	Pin
0	A1	8	C20	16	C24	24	C28
1	C16	9	C12	17	C8	25	C4
2	C17	10	C21	18	C25	26	C29
3	C15	11	C11	19	C7	27	C3
4	C18	12	C22	20	C26	28	C30
5	C14	13	C10	21	C6	29	C2
6	C19	14	C23	22	C27	30	C31
7	C13	15	C9	23	C5	31	C1

The enclosed components diagram indicates the position of the operational amplifier on the circuit board so that it can be easily located and exchanged if required.

The lower section of the same circuit diagram shows the supply voltage ±15 VOLT which is fed via the miniature connector of the dispersion unit.

```
+ 15 VOLT is fed via its pins 1, 2, 15, 16
   Ground is fed via its pins 3, 4,  5, 12, 13, 14
- 15 VOLT is fed via its pins 6, 7, 10, 11.
```

This program can be interrupted by entering RETURN. The symbol for the system level then reappears on the screen in the subdirectory "Service".

This "service" subdirectory is exited by entering

CD and subsequent initiation with **RETURN.**

The program of the "analysette 22" is then started by calling up the program with its name SIZEREXE.EXE. This is done by entering

C> SIZEREXE and initiating with **RETURN.**

The program starts automatically and the main menu appears on the screen after a short time.

14.4 Readjustment of Laser Optics

Caution:

The adjustment ring of the laser optics must not be adjusted in any way unless absolutely necessary.

Protective goggles should be worn at all times when working on the actuated laser!

A lens system is fitted to the laser transmitter (concealed in the right-hand section of the housing). These lenses concentrate the laser beam onto a diaphragm (25 µm). This diaphragm functions as a highly stable spatial filter and generates an undisturbed beam with Gaussian intensity distribution behind the filter. The diverging beam coming from the diaphragm strikes the adjustment lens which focusses the laser beam in the centre of the sensor. The optical components, diaphragm and adjustment lens have fixed relative positions.

If the laser optics (brass knurled screw) are accidentally turned, the diaphragm setting must be checked and readjusted if necessary.

For checking purposes, a piece of white card is held to the right of the adjustment lens with the laser activated. If the laser optics are correctly adjusted, a round, white spot of light of approx. 12 mm diameter appears on the card. This spot of light will have a sharp edge and no other light spots will be visible.

If the image on the card does not agree with this description, the diaphragm must be readjusted.

The diaphragm is fixed in position in the brass screw and is shifted in longitudinal direction by turning the screw.

The brass screw - supporting the diaphragm - is fixed to one side of a 3-section flange which can be moved in "x - y" direction. If the brass screw has been moved only slightly -its position along the unit's longitudinal axis remaining practically the same - the correction in "x - y" direction is all that is required for readjustment.

Two pair of pins fitted at right angles to each other serve as precision guides in the 3-section flange (connection of lens system to diaphragm). The first flange section is fixed to the lens system, the second can be moved in "x" direction via a pair of alignment pins and the third section can be moved in "y" direction via a pair of alignment pins fixed to the second section. The sections are moved by turning a threaded pin with hexagon socket (1.5 mm). Fitted on the opposing side of these adjustment screws are spring-mounted studs for fixing the flanges.

Before the setting can be adjusted by turning the threaded pins, the spring-mounted studs on the opposite sides must be unscrewed slightly.

The threaded pins are then screwed in and out using a suitable Allen key until the image on the card takes the required form.

This readjustment can be performed in a few minutes with a little practice. If, nevertheless, the adjustment still proves unsuccessful, the knurled screw can be unscrewed a maximum of one turn to make it easier to "catch" the beam emerging from the diaphragm. The beam striking the diaphragm is thus enlarged and can be "caught" more easily.

For final adjustment, an image is initially set which is as good and round as possible. The brass knurled screw is then screwed in approx. 1/4 turn and readjustment then performed again in "x - y" direction. This procedure is repeated until the knurled screw is once again at the "correct" position and the image has the required round contour of uniform intensity. No other light spots may be visible.

Once the adjustment has been completed, the spring-mounted studs are once again screwed into the sides lying opposite the threaded pins. The adjustment is then checked again.

14.5 Exchanging the Sensor

The sensor is a very delicate electronic element and it is extremly sensitive against mechanical strength. After a long period - or after damaging it must be exchanged. Changing the sensor should be done very carefully. Specially the surface of the sensor must not be touched. The plastic cover for protecting the surface of the sensor must not be removed before fixing the new sensor with the 4 nuts in correct position.

At first the cables for the mains and for the $\pm$ 15 volts has to be disconnected.

Open the right side cover. This cover moves like the main middle cover i.e. is to be opened like a door after unscrewing the 2 lower front screws.

With a caliber measure the distance between the flange and the plate which holds the sensor in position. This makes sure that the new sensor may be fixed in same position as the old one.

Unscrew the lower screw on the left side of the right side flange which enables to adjust and fix the sensor plate in "z" direction (adjust in left and right directions; this screw is spring-loaded)

Move as much as possible without destroying something the black plate bearing the sensor and amplifiers to the right side so that you may look on the silicon surface of the sensor.

By means of for example a small screwdriver disconnect the plug and the lower part from the sensor. (Bringing the screwdriver carefully into the split between plug and sensor after turning it slightly the plug may at first be loosen and finally be disconnected.)

Unscrew the 4 nuts which fix the sensor on the bearing plate. (Keep the washers). Now you may lift off the sensor.

The new sensor (with cover) must now be connected to the plug and after this contrived to the 4 screws (each screw must wear one washer). Put on the second washer on each screw and fix the nuts - but not too strong. The torque you may apply with two fingers is sufficient. Now the cover may be removed.

Bring the plate in upright position, fix it with the above mentioned screw so that the measured distance is the same.

After closing the housing the laser beam has to be realigned. (See point 4.2 and 4.3).

15. Guarantee

The guarantee card accompanying delivery of the unit must be completed in full and returned to the manufacturer to be valid.

Fritsch GmbH Laborgerätebau, Idar-Oberstein, and its
"Application Laboratory" or respective agencies abroad will be pleased to provide further information and advice.

Any inquiries should be accompanied by details of the serial number given on the nameplate.

16. Bulletin, Information, Tips and Tricks

16.1 Foreword

In addition to general information, tips and tricks, we would also like to publish details of practical experiences which we and our customers have had with the "analysette 22", and which may be useful for other applications.

16.2 Transferability of Measurement Results

When a particle measurement is used to determine which of its assumed qualities correspond to tangible reality, it should be remembered that the person conducting the measurement is not merely an observer and the measuring instrument not merely a tool, but that both function actively with each other. Consequently, when researching into particle size distributions, both play their part in the overall scheme of affairs.
When developing equipment for particle size distribution, the designer always attempts to eliminate the influence of the operator as far as possible. The influence of the applied physical process or its realization in the unit affects the final result.

If, for example, a particle size distribution is determined using the sedimentation process ("analysette 20" scanning photo- sedimentograph), at least slightly changed results can be expected since, in this case, the "sedimentation speed equivalent diameters" are determined - in the same way as an image analysis (being a plan view onto the particles) shows up deviating shapes.

When measuring particle sizes using the analysis of a diffraction image, all dimensions of the particles are "seen" and are taken into account accordingly in the result. It also determines the length. When the particle size distributions of various measuring processes are compared or transferred, it is necessary, for example, to take this into account.

16.3 Selection of Liquids for Suspensions

Besides water, a number of monovalent, divalent and trivalent alcohols (ethanol, isopropanol, glycol or glycerol), gasolines (petroleum ether), mineral oils (petroleum) and organic oils (soya oil, nut oil) can be used as test liquids. It is also possible to use e.g. cyclic aromatic substances (ring hydrocarbons such as toluene, benzenes or aniline). The system is also resistant to alkanes (hexane, heptane) and aldehydes (formaldehyde).

No other liquids may be used withour prior consultation with the manufacturer.

The following must not be used:

Ketones (acetone), ether, fluorochlorohydrocarbons, chlorinated hydrocarbons, acetic acid and its derivatives, undiluted acids and bases.

Even samples available in oil (e.g. oils similar to machine oil) do not have to be measured in oil.

Example: Toner in machine oil

The sample is first dispersed in ethylene glycol with a drop of surfactant in an ultrasonic bath. This is then mixed with water on a 1:1 basis, the mix then being poured into the ultrasonic bath of the "analysette 22" laser particle sizer.

Example: Raw chocolate substance

Raw chocolate substance is generally measured in acetone or benzene (already familiar from the screening process). The measurement can be performed on the "analysette 22" laser particle sizer in e.g. peanut oil. Since peanut oil can be used with foodstuffs, there are no contamination problems and the "waste oil" can be used for lubricating the rollers.

Generally speaking, liquids with a viscosity of up to
30 cPoice can be pumped without problem by the conveying system of the dispersion unit.

16.4 Dispersion of Highly Hydrophobic Samples

Despite their water-repellent characteristics, hydrophobic samples can still be dispersed if they are first treated with a liquid surfactant and then dispersed under the action of constant stirring in water.

Similarly, agglomerates are dispersed more easily and quickly in an external ultrasonic bath. In the case of soil samples, for example, a 0.1% sodium pyrophosphate solution is recommended as a dispersion agent. The sample prepared in this way can then be measured in pure water.

16.5 Measurement of Slightly Soluble Samples

The "analysette 22" laser particle sizer can also be used to measure samples which are only slightly soluble in liquid. A saturated test liquid should be prepared. In such a liquid, the particle size cannot change due to dissolving, and the test results are therefore not adulterated. (The saturated solution should, however, be filtered off before usage.)

In the case of extremely expensive products, it may be worth-while looking for a substitute substance which takes over the task of "saturating" the test liquid.

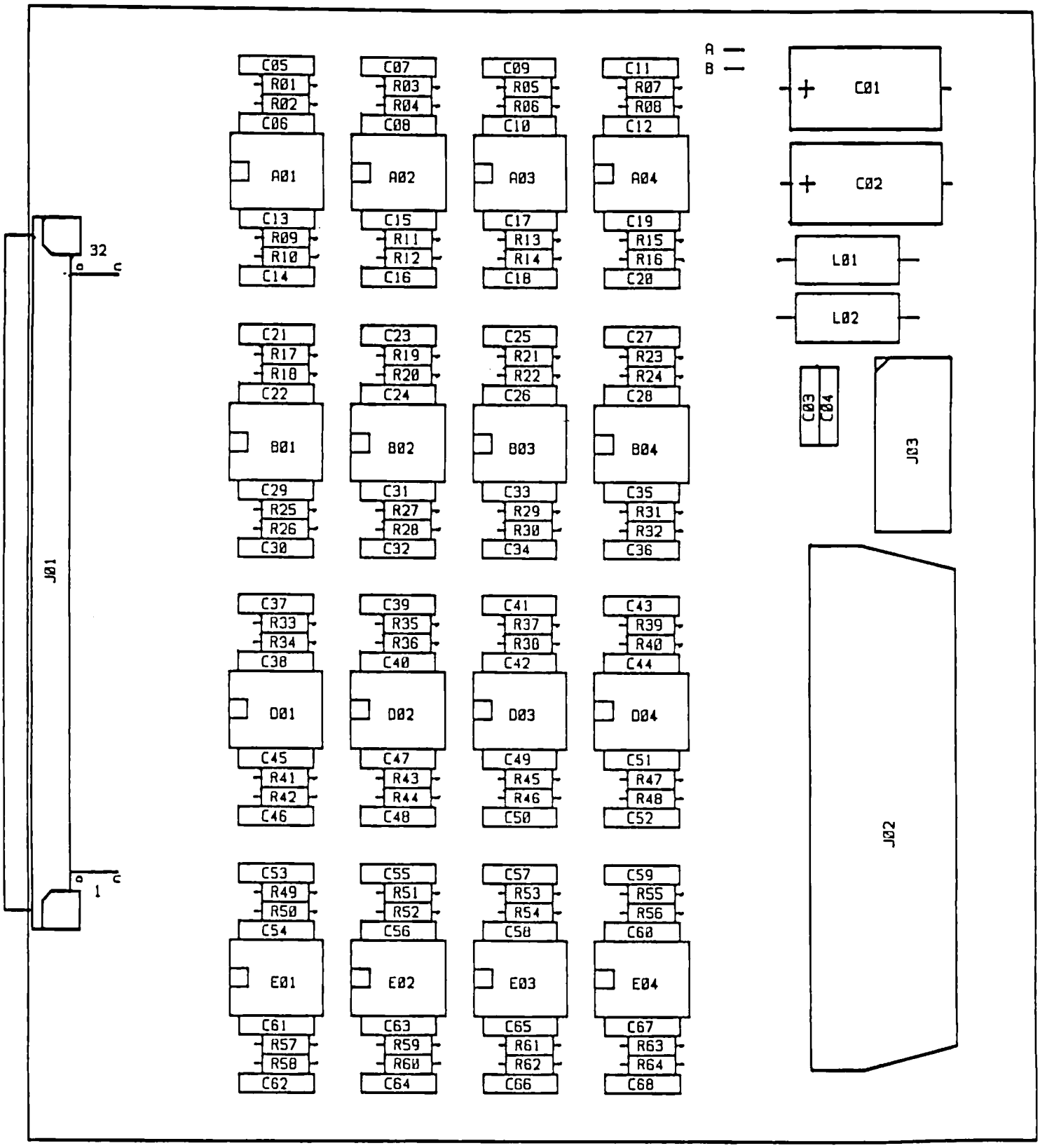
16.6 Calculation Method Based on Rosin-Ramler (RRSB)

For a number of applications it is preferable to present a particle size distribution in the RRSB network. This form of presentation enables additional information to be gleaned.

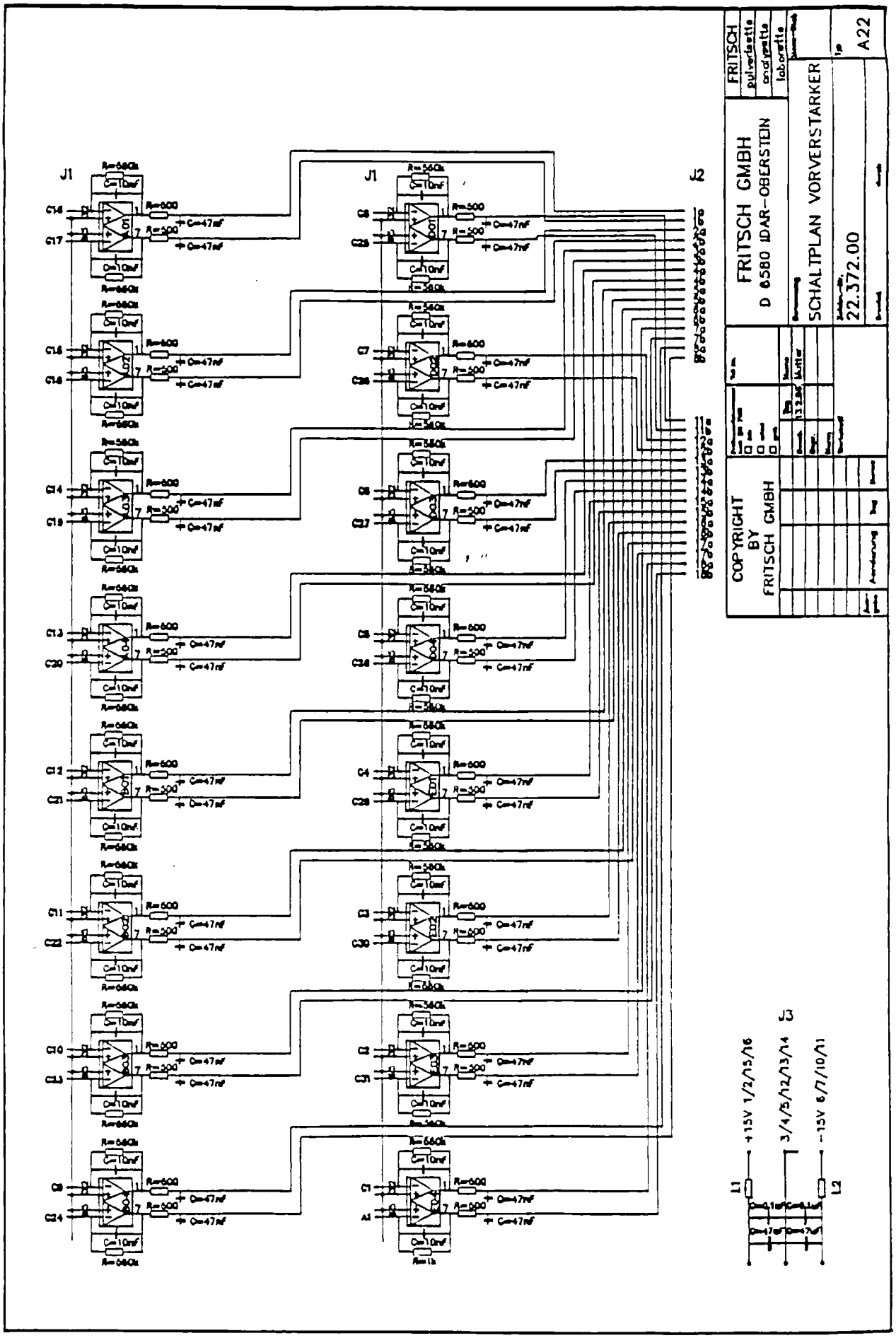
The mass distribution cumulative curve (undersize D as a function of a particle equivalent diameter) is plotted in the RRSB network (DIN 66145, named after the authors Rosin, Ramler, Sperling and Bennett). If the grain size distribution function follows the RRSB function, the distribution cumulative curve in this network takes the form of a straight line.

Using the program of the "analysette 22" Laser Particle Sizer, it is possible when calculating the particle size distribution to select the RRSB particle size distribution in the "Initialisation" main program (see page 10, function key "F 5" Calculation Type). This assumes that the distribution to be measured in the RRSB network will produce a straight line.

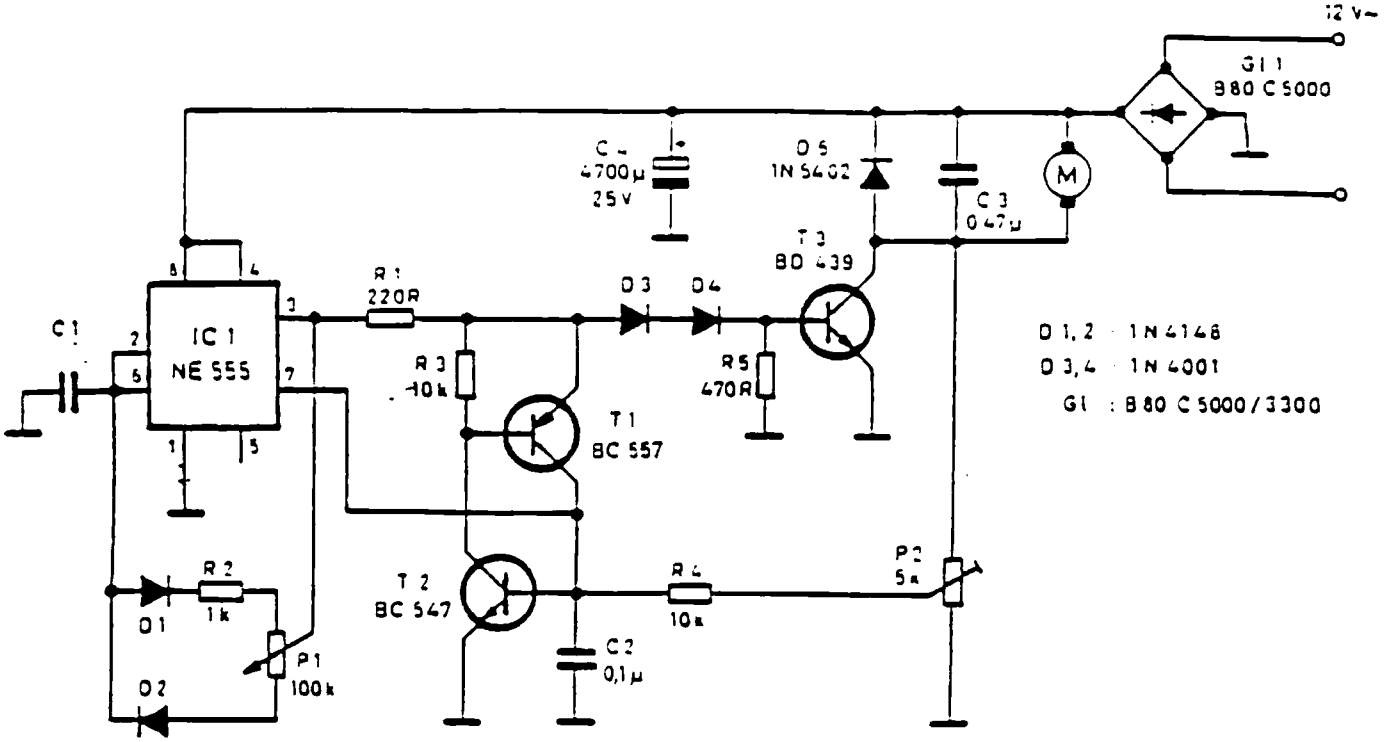
The results curve which is then calculated and plotted can be used to determine, e.g. the fineness parameter "d'" from the abscissa section at D = 0.632 and the rate of rise of the RRSB straight line. After parallel displacement of the straight lines to the coordinate origin, the inner horizontal abscissa gives the second fineness parameter "n". The outer horizontal abscissa also provides the non-dimensional surface value. Both can be used to determine the volume-related surface "S_v" by division. If "d'" is expressed in cm, "S_v" is given in cm^2/cm^3 or in 1/cm. The mass-related surface is obtained by dividing the volume-related density by the specific density " ": $S_m = S_v/$.

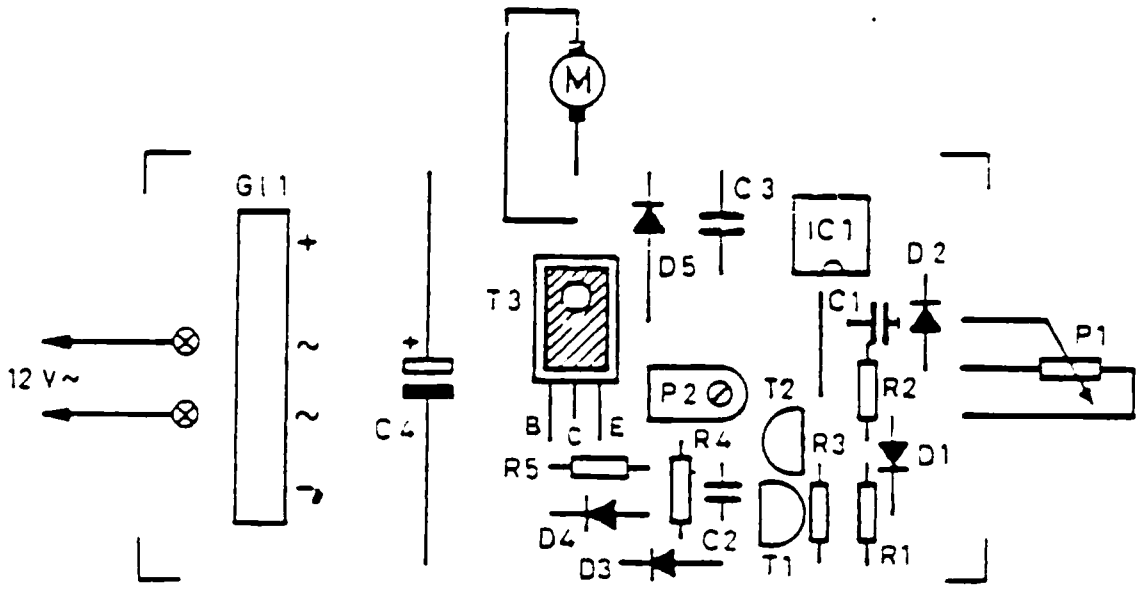


Preamplifier 03.06.1986



Preamplifier 03.06.1986



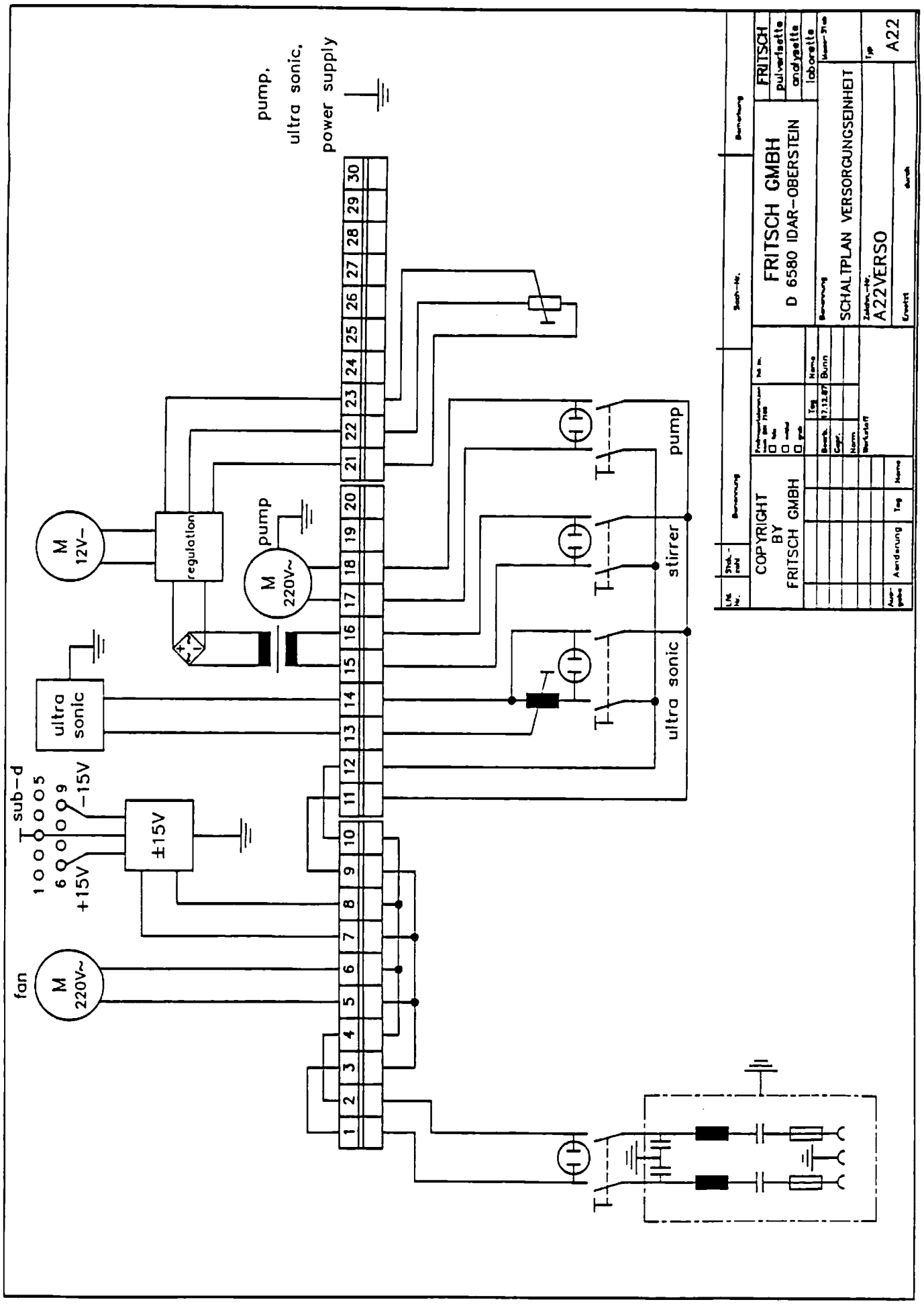


Parts list:

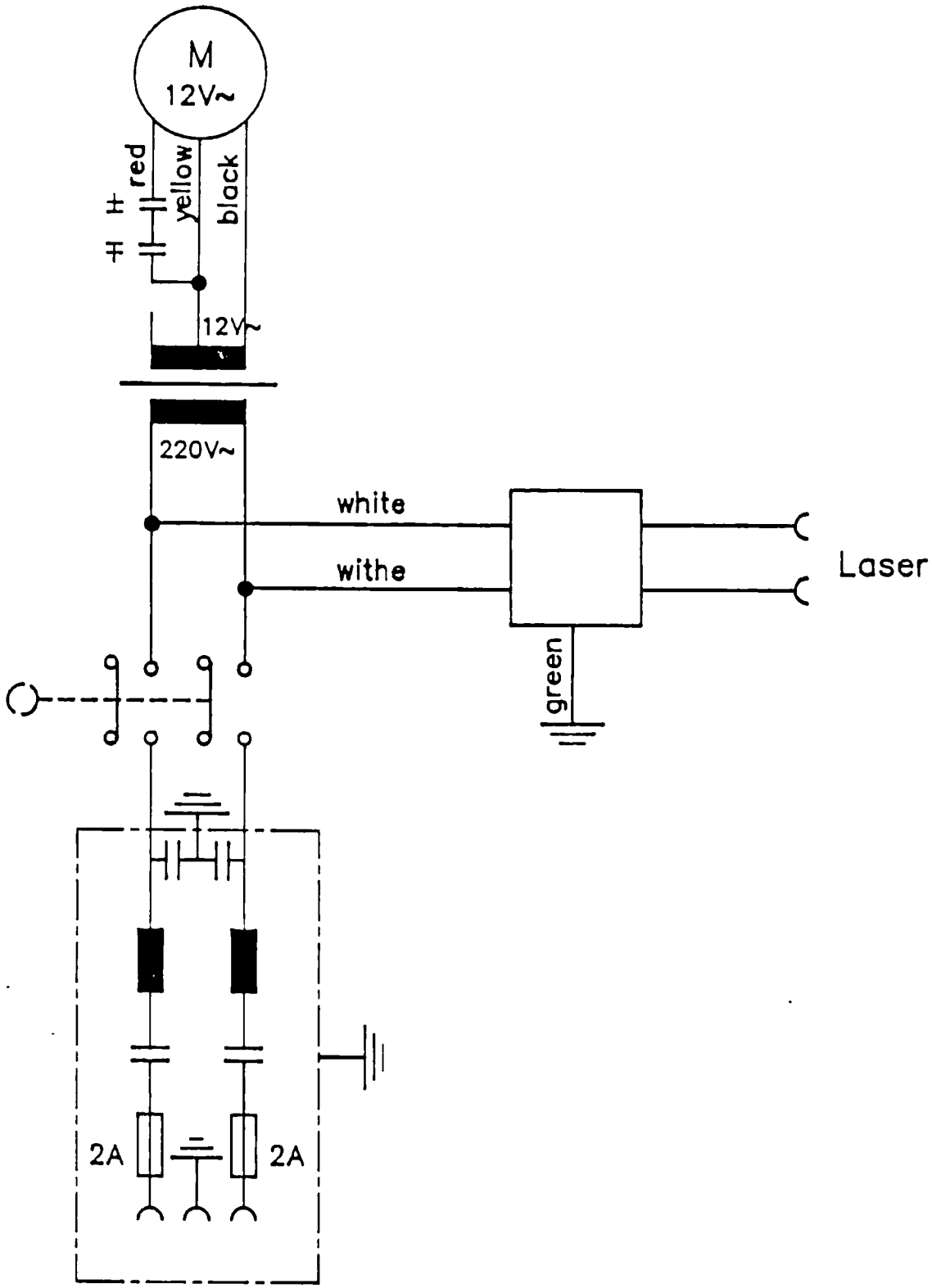
Resistors	(1/4 W,5%)	Capacitors	
R1	220R	C1	1500n
R2	1k0	C2	100n
R3,4	10k	C3	470n
R5	470R	C4	4700,u/25V Elko

Semiconductor			
IC1	NE 555	T1	BC 557
T2	BC 547	T3	BD 439
D1,2	1 N 4148	D3,4	1 N 4001
D5	1 N 5402	G11	B 80 C 5000

Circiut diagram for stirrer



Circuit diagram suspension unit



Lfd. Nr.	Stck.-zahl	Benennung	Sach-Nr.	Bemerkung

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Freimaßtoleranzen nach DIN 7168
☐ fein
☐ mittel
☐ grob

Tol. Nr.

	Tag	Name
Bearb.	17.12.87	Bunn
Gepr.		
Norm		

Werkstoff

Ausgabe	Aenderung	Tag	Name

FRITSCH GMBH
D 6580 IDAR-OBERSTEIN

FRITSCH
pulverisette
analysette
laborette

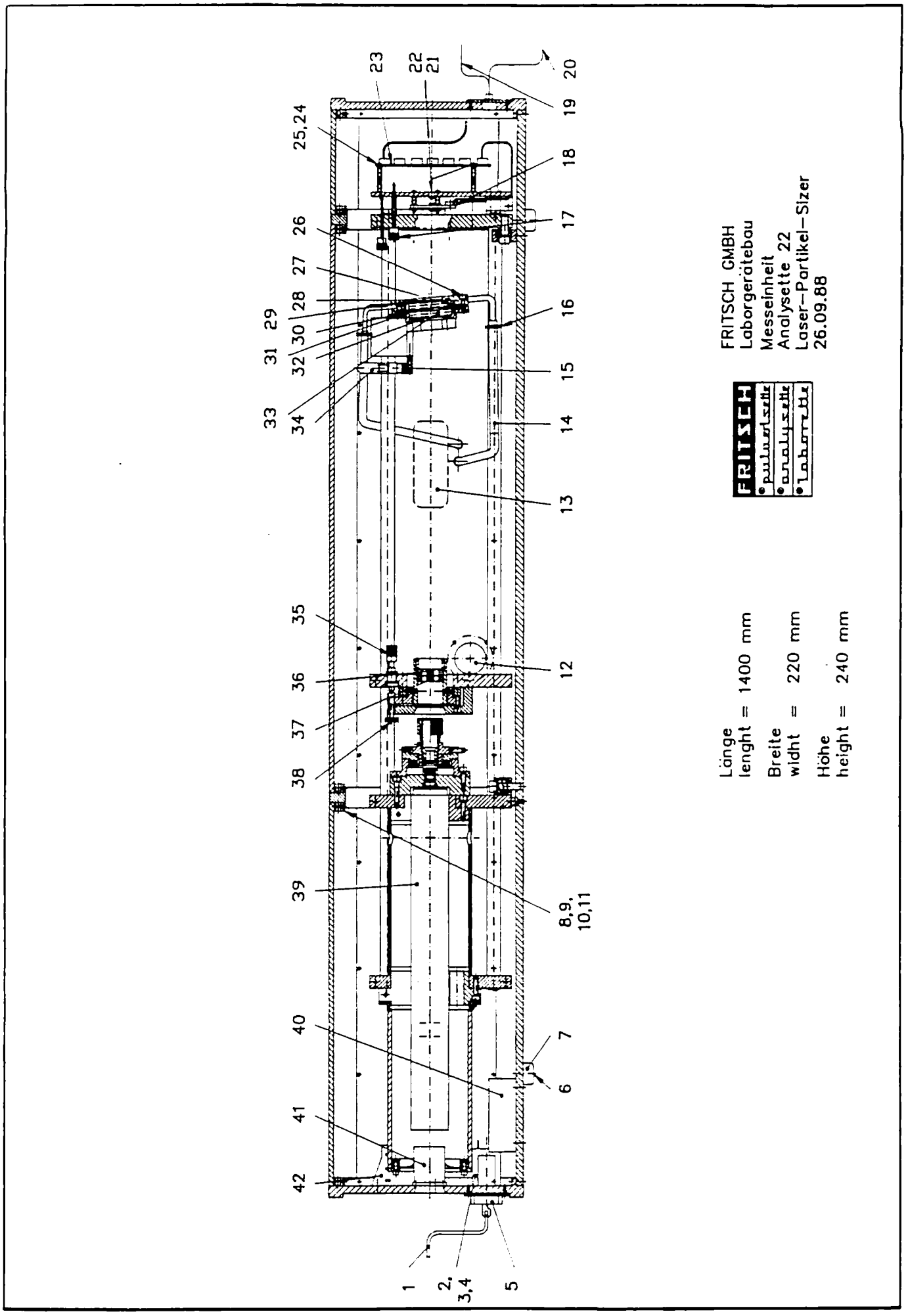
Benennung
SCHALTPLAN MESSEINHEIT

Maße-Stab

Zeichn.-Nr.
A22MESSE

Typ
A22

Ersetzt durch



Measuring Unit (Drawing for spare parts list)

ERSATZTEILLISTE SPARE PARTS LIST	LASER-PARTIKEL-SIZER LASER PARTICLE SIZER	MESSEINHEIT MEASURING UNIT	A-22	220V	23.09.1988

NR.	ARTIKELNR.	BEZEICHNUNG	DESCRIPTION	ME	PREIS/ME IN DM
A	22.220.00	Gehause fur Nassmessung	housing for wet measurement	S	
1	81.710.00	Gerateanschlussleitung	instrument connecting cable	S	
2	83.100.00	Universal Combicon Filter	universal combicon filter	S	
3	81.415.00	Sicherungseinsatz fur Filter	fuse for filter	S	
4	81.502.00	Schmelzsicherung 2A mt	melting fuse 2A slow	S	
5	81.439.00	Schloss-Schalter	locking-switch	S	
6	93.403.15	Gehausefuss	housing foot	S	
7	91.282.09	Zyl. Schraube, M4x16 DIN 84	cylinder head screw, M4x16	S	
8	22.332.13	Scharnier	hinge	S	
9	92.108.10	Zyl. Stift, 6m6x16 DIN 6325	straight pin, 6m6x16	S	
10	91.337.09	Gewindestift, M3x6 DIN 914	headless pin, M3x6	S	
11	91.125.09	Zyl. Schraube, M3x8 DIN 912	cylinder head screw, M3x8	S	
12	22.402.16	Verschlusskappe Rückwand	rear stopper cap	S	
13	92.611.00	Griffschale	recessed grip	S	
14	84.905.16	Schlauch ø10/6mm, Silikon	tube 10/6mmø, silicon	S	
15	92.618.00	Rändelknopf, M4	knurled knob, M4	S	
16	84.703.00	Befestigungs-Schelle	tube clamp	S	
17	92.612.00	Rändelknopf, M3	knurled knob, M3	S	
B	22.270.00	Vorverstarker mit Sensor	pre-amplifier with sensor	S	
18	81.841.00	Sensor	sensor	S	
19	81.742.00	Kabel für Signalleitung	cable for signal transmission	S	
20	81.743.00	Kabel fur Spannungsversorgung, 15V	cable for power supply, 15V	S	
21	81.915.00	Fotodiode	photodiode	S	
22	81.916.16	Montageklip	assembling clip	S	
23	22.469.00	Vorverstarkerplatine, kpl.	pre-amplifier PCB, cpl.	S	
24	91.085.16	Scheibe 2,5 DIN 125	disk 2,5	S	
25	91.100.10	Zyl. Schraube, M2,5x8 DIN 84	cylinder head screw, M2,5x8	S	
C	22.260.00	Flüssigkeitsmesszelle, kpl.	measuring cell for suspensions, cpl.	S	
26	91.216.10	Zyl. Schraube, M4x16 DIN 912	cylinder head screw, M4x16	S	
27	84.908.20	Schlauch , ø 2/1mm, Teflon	tube, ø 2/1mm, teflon	S	
28	22.324.10	Flansch Fenster	flange window	S	
29	84.008.15	O-Ring, 40x2,5	o-ring, 40x2,5	S	
30	84.009.15	O-Ring, 64x3	o-ring, 64x3	S	
31	22.323.10	Stromungsscheibe	flow disk	S	
32	22.325.10	Flansch fur Durchflusszelle	flange for flow cell	S	
33	22.458.26	Planparallelplatte, 50x8(Satz=2St)	plane-parallel plate, 50x8(2pcs.)	S	
34	22.348.10	Zeiger ab 1989	pointer since 1989	S	
	22.328.10	Zeiger bis Serie .11.1988	pointer until .11.1988	S	
D	22.250.00	Verstell-Linse, kpl.	lens system, cpl.	S	
35	92.930.00	Mikrometerschraube	micrometer screw	S	
36	22.463.26	Linse, ø=31,5 , F=600	lens, 31,5ø , F=600	S	
37	22.462.26	Linse, ø=31,5 , F=100	lens, 31,5ø , F=100	S	
38	92.619.00	Rändelhohlschraube	knurled screw	S	
E	22.230.00	Laserhalterung, kpl.	laser holder, cpl.	S	
39	22.461.00	Laser	laser	S	
40	22.460.00	Netzgerat	power supply	S	
41	81.834.00	Miniventilator	mini cooling fan	S	
42	81.110.00	Netztransformator	power transformer	S	

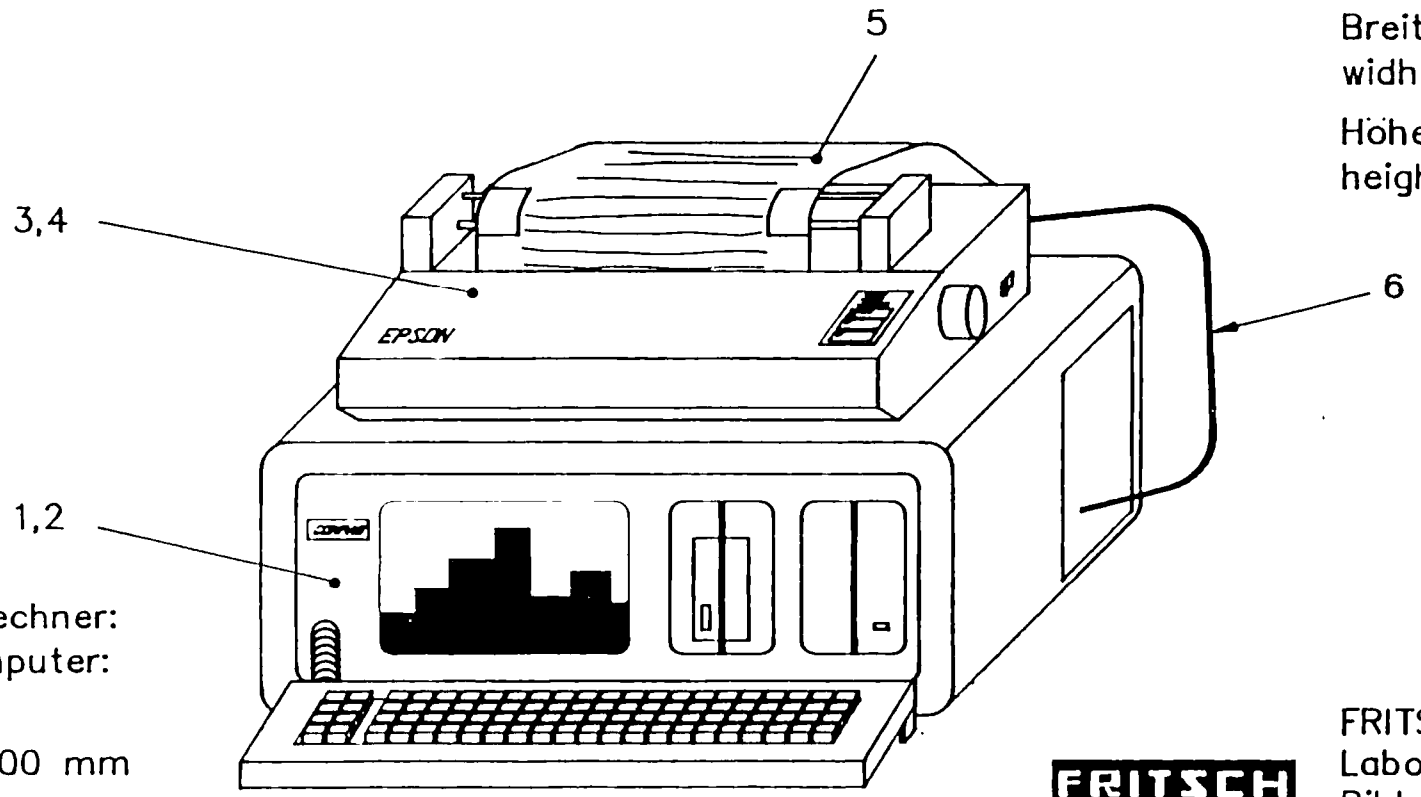
Measuring Unit (Spare parts list)

Matrix–Drucker:
matrix printer:

Länge
lenght = 430 mm

Breite
widht = 380 mm

Höhe
height = 130 mm



Bildschirmrechner:
screen computer:

Länge
lenght = 500 mm

Breite
widht = 580 mm

Höhe
height = 230 mm

FRITSCH
•pulverisette
•analysette
•laborette

FRITSCH GMBH
Laborgerätebau
Bildschirmrechner +
Matrix–Drucker
Analysette 22
Laser–Partikel–Sizer
14.07.87

ERSATZTEILLISTE LASER–PARTIKEL–SIZER BILDSCHIRMRECHNER + MATRIX–DRUCKER

SPARE PARTS LIST LASER PARTICLE SIZER SCREEN COMPUTER + PRINTER

A–22 220V 07.09.1988

NR.	ARTIKELNR.	BEZEICHNUNG	DESCRIPTION	ME	PREIS/ME IN DM
1	22.480.00	Bildschirmrechner	screen computer	S	
2	22.410.00	Diskette, formatiert	diskette, formatted	S	
3	83.520.00	Matrix–Drucker	matrix printer	S	
4	83.004.00	Farbband für Matrix–Drucker	ink ribbon for matrix printer	S	
5	83.002.00	Papier für Matrix–Drucker (2000 Bl.)	paper for matrix printer (2000 pages)	S	
6	81.741.00	Druckerkabel, 1,5m	cable for printer, 1,5m	S	
	83.510.00	Laser–Drucker	laser printer	S	
	83.003.00	Tonerkassette für Laser–Drucker	toner cassette for laser printer	S	
	83.006.00	Trommel für Laser–Drucker	cylinder for laser printer	S	

Computer, Matrix printer (Spare parts list)

ERSATZTEILLISTE NASS-DISPERGIEREINHEIT 31.05.90
SPARE PARTS LIST wet-dispersing unit A22 22.210.00 110V /220V

NR.	ARTIKELNR.	BEZEICHNUNG	DESCRIPTION	ME	PREIS/ME IN DM
1	22.409.10	Stab Ruehrer	stick stirrer	S	
2	92.143.10	Nummernschildschraube mit Kappe	number plate screw with cap	S	
3	22.468.00	US-Generator	us-generator	S	
4	22.471.00	Schwingwanne	moving tub	S	
5	81.222.00	Motor A-22 fuer Edelstahlpumpe	motor A22 for highgrade steel pump	S	
6	81.228.00	Motor fuer Ruehrer A22	motor for stirrer A22	S	
7	81.415.00	Sicherungseinsatz	fuse inset	S	
8	81.438.00	Ausschalter A22	off-switch A22	S	
9	81.440.00	Schalter A22 2-polig	switch A22 (two poles)	S	
10	81.502.00	Schmelzsicherung 2A t	fuse 2A lazy	S	
11	81.710.00	Geraeteanschlussleitung	instrument connecting cable	S	
12	81.806.00	Drehknopf,gross	turn-button , big	S	
13	81.820.00	Impulsregelung Gleichstrommotor	impulse regulation DC-motor	S	
14	81.838.00	Ventilator	fan	S	
15	83.100.00	Universal Combicon Filter	universal combicon filter	S	
16	84.601.10	Kugelhahn	ball valve	S	
17	84.607.00	Pumpe Edelstahl A22	pump,highgrade steel A22	S	
18	84.604.00	Reduzier Schott Verschr.	connecting pipe	S	
19	84.703.00	Befestigungsschelle	fixing clamp	S	
20	84.905.16	Schlauch D=10/6 Silikon	tube D=10/6 silicon	S	
21	84.906.16	Schlauch D=10/6 Viton	tube D=10/6 viton	S	
22	86.816.00	Netzteil	power pack	S	
23	86.826.00	Feinsicherung 1.25A traege	fine fuse 1.25A lazy	S	
24	86.817.00	Stelltrafo	regulating transformer	S	
25	93.403.15	Gehaeusefuss	housing foot	S	
26	90.028.16	Ruehrer	stirrer	S	
				S	
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				S	
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ERSATZTEILLISTE Trocken-Dispergiereinheit
SPARE PARTS LIST dry-dispersing unit

17.08.89

A22 22.810.00 110V /220V

NR.	ARTIKELNR.	BEZEICHNUNG	DESCRIPTION	ME	PREIS/ME IN DM
1	22.811.00	Busplatine Trocken,kpl.	bus pcb, dry, cpl.	S	
2	22.813.00	Buerstenplatine Trocken	brush pcb, dry	S	
3	22.815.00	Vorschubplatine Trocken	advance pcb, dry	S	
4	22.817.00	Netzteil Start/Stop Trocken	power pack start/stop, dry	S	
5	22.819.00	Bedienelementeplatine Trocken	operational control pcb, dry	S	
6	22.820.00	Nachdispergierduese,kpl.	redispersing nozzle, cpl.	S	
7	81.440.00	Schalter A22 2-polig	switch A22 2-pol.	S	
8	81.710.00	Geraeteanschlussleitung IEC 83/C4	instrument connecting cable IEC 83/C4	S	
9	81.821.00	Ventilator 80x80 220V	fan 80x80 220v	S	
10	86.816.00	Netzteil PSM215	power pack PSM215	S	
11	92.932.00	Scharnier	hinge	S	
12	92.933.00	Schnappverschluss	snap	S	
13	93.420.16	Abdeckung	covering	S	
14	95.101.00	Druckschalter	manometric switch	S	
15	95.102.00	Magnetventil	electrovalve	S	
16	95.103.00	Manometer	manometer	S	
17	95.104.00	Druckminderer	pressure reducter	S	
18	95.105.00	Durchflussmengenregler	flow governor	S	
19	22.896.16	Stopfer	stopple	S	
20	22.897.16	Buerste GD 40x0.5	brush GD 40x0.5	S	
21	81.203.00	Buerstenmotor	brush motor	S	
22	81.204.00	Vorschubmotor	feed motor	S	
23	81.318.00	Getriebe Vorschubmotor	gear , feed motor	S	
24	81.470.00	Mikroschalter	micro switch	S	
25	82.202.00	Bogenzahnkupplung	bow denture clutch	S	
26	82.519.00	Rillenkugellager	deep grove ball bearing	S	
27	84.550.15	Dichtung Turcon-Variseal-M	seal Turcon-Variseal-M	S	
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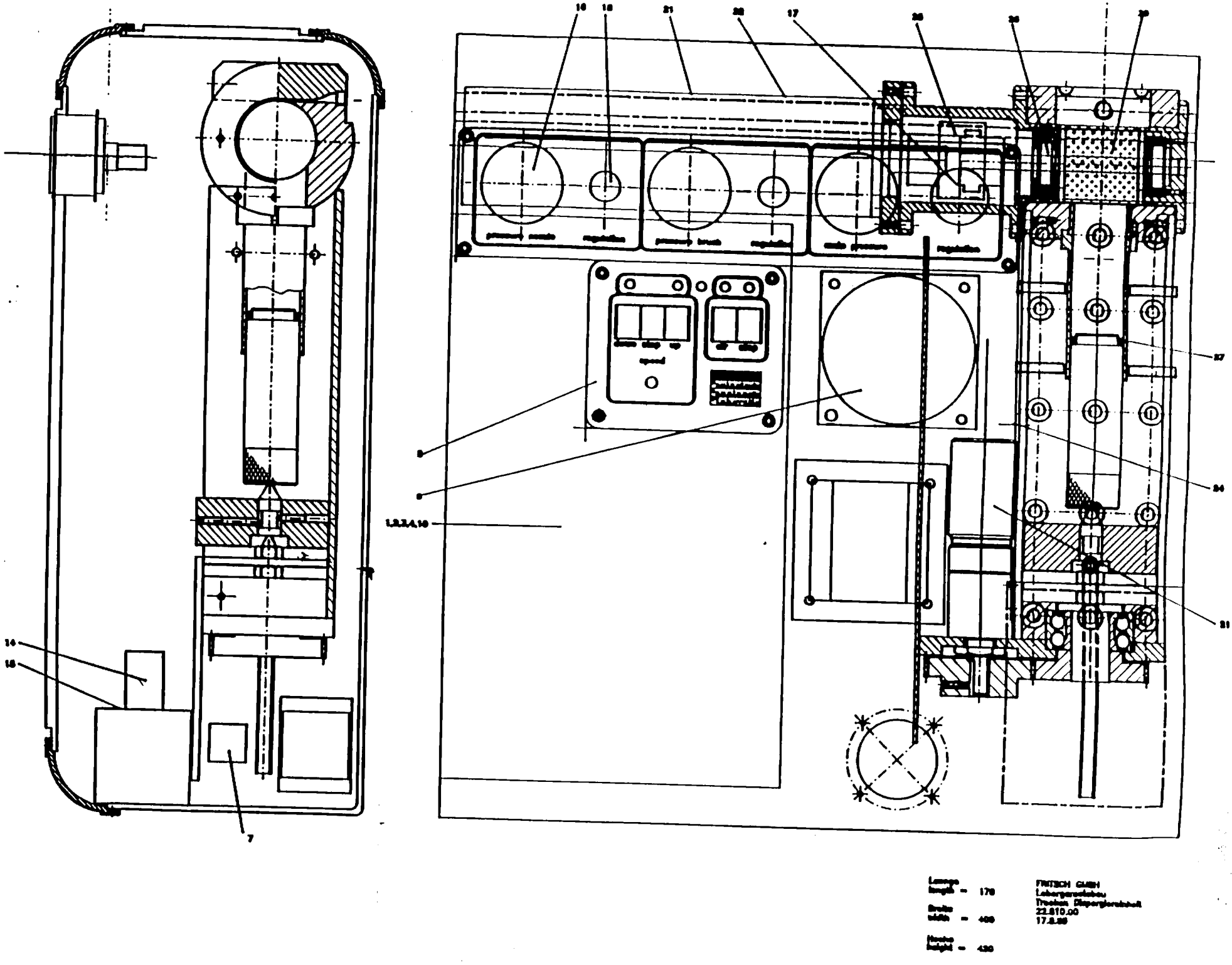

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Laborgerätebau
Trockem Steingerätebau
22.810.00
17.8.89

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